THE

ENGINEERING MAGAZINE

85-899

AN INDUSTRIAL REVIEW

VOLUME XVII

April to September, 1899

NEW YORK

THE ENGINEERING MAGAZINE

1899

COPYRIGHT, 1899,
BY JOHN R. DUNLAP

THE

ENGINEERING MAGAZINE

VOL. XVII. APRIL, 1899. NO. 1.

THE MONITOR, THE BATTLE-SHIP, THE CRUISER, AND THE DESTROYER.

By G. W. Dickie.

THE subject of this article is not of my own choosing. When the editor steered this fleet into my harbor he asked me to look at the vessels and give my opinion of their usefulness, as types of fighting ships. He asked me to consider whether the Spanish-American war suggested any modifications of these types or the further consideration of European practice and late designs. He also asked me to compare the types as to functions, sphere of action, and relative efficiency, and to examine the matter of their apportionment, as to number and service, in a naval establishment.

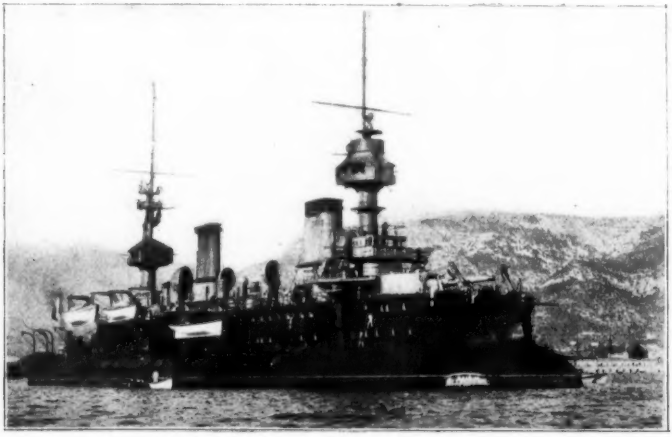
In attempting to comply with this request, I must, at the outset, acknowledge that, although I have had a little experience in the building of each type of war-ship represented in the title of this article, I am by no means qualified to write with authority on the qualities most to be desired in these various types of war-ships, especially within the limits here set. I must therefore confine myself to the expression of my own opinion in regard to the designs at present accepted for these various types of fighting vessels; and this I purpose doing from the engineer's and shipbuilder's point of view. These types I will consider in the order given.

THE MONITOR.—This type of war vessel is not the result of development from simpler forms that suggested the direction of improvements; it is an invention that embodied at first all the principles that characterize the type to-day; it was born of necessity, and has held a place in the United States navy since its advent, because of the good work done by the first vessels of the class.

Copyright, 1899, by John R. Dunlap.

The United States navy, however, is the only one that has a class of vessels that can be called monitors. While this type was the direct cause of many modifications in the hulls and batteries of the battle-ships in the navies of Europe, in no case was it adopted as a type. The very low freeboard and light draught of the monitor did not appeal to the British and French naval constructors as qualities worth the sacrificing of so many desirable qualities; so they took from the monitor some of its peculiar features, and worked them into their own designs in such a way as to completely hide the type. It is only when we take these designs apart that we find the monitor embodied in the very center of their structure.

Take the British war-ship Dreadnought, and remove the upper deck and sides, forward and aft, to the berth deck, and you have practically the double-turreted monitor left, with the superstructure armored, and the draught of water greater than the monitor's.



A HIGH-FREEBOARD FRENCH BATTLE-SHIP—THE MASSÉNA.

11,924 tons, 13,500 i.h.p., 17 knots; 347.6 x 66.3 x 26.3 feet; 2 12-inch guns in separate turrets fore and aft; 2 10.6-inch in separate turrets on the beam; 8 5.46-inch quick fire; 8 3.9-inch quick fire; 12 3-pdr., 8 1-pdr., and 4 1-pdr. quick fire.

The French ships Tréhouart and Bouvines may be regarded as modified monitors, but these ships have had a superstructure added forward, to improve their sea-going qualities, since they went into commission.

The monitor, therefore, as a distinctive type, not only originated

in America, but is found nowhere else. In the country of its origin it holds a high place in popular estimation, and could not be abandoned by American naval authorities without reasons strong enough to convince congress.

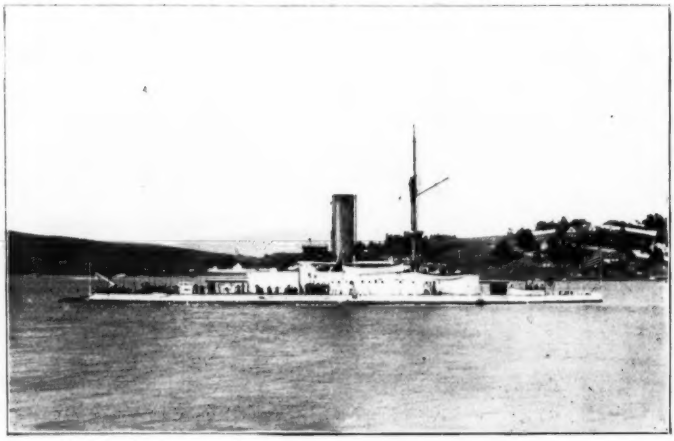
Amongst American naval officers, and especially among those

H. M. S. DREADNOUGHT.

10 820 tons, 6,500 i.h.p., 13.5 knots; 320 x 63 10 x 26.9 feet; 4 12.5-inch guns, in pairs, in turrets; 6 6-pdr. and 12 3-pdr. quick fire; 7 machine guns: 2 torpedo tubes to be fitted.

who have commanded or served on monitors, this type is considered a very important factor in the navy. Some of these officers claim for it that it has a more extended sphere of usefulness than has been assigned it by its designers. There is no doubt that monitors have frequently performed duties for which they were not intended, and have succeeded to a certain extent in performing these duties satisfactorily. For instance, there were several monitors in the seagoing fleet under Admiral Sampson, and the Monterey and Monadnock were sent from San Francisco to Manila; yet the monitor type would never be designed and built for such service. Admiral Sampson did not consider his fleet very much improved by the presence of the monitors, and the Monterey and Monadnock reached Admiral Dewey only by being towed most of the way.

The monitor is essentially a harbor-defence vessel, and its great advantage lies in the fact that so little of the vessel is out of water, making armor protection possible and effective, with little weight, and enabling a heavy battery to be carried on a comparatively small displacement, which means small dimensions and light draught. All



U. S. MONITOR MONTEREY.

4,138 tons, 5,072 h. p., 14.4 knots; 256 x 59 x 14.9 feet; 2 12-inch guns in fore barbette, 2 10-inch in aft barbette; 6 6-pdr. and 4 1-pdr quick fire; 2 Gatlings.

these qualities are very good, and if they were accompanied by others necessary in a sea-going vessel, the monitor would have a wider range of action than can now be accorded it.

The small amount of exposed hull means a low freeboard. This renders speed practically unattainable. The Monterey, with 4,000 tons' displacement, has, say, 30 inches' freeboard; draught of water, 14 feet. In smooth water, at 10½ knots, the wave comes over the bow. At full power, 5,200 horse, the depth of water above the stem is about 7 feet, and at the forward barbette the water is 18 inches deep on deck. Speed therefore is out of the question. The small dimensions and shallow draught, coupled with the small range possible between normal and load water lines, renders large coal-capacity impossible. Hence the radius of action is limited to a small circle.

The main battery, being carried so near the water-line, can be used only in practically smooth water. In short, the monitor is an ideal harbor-defence vessel, and should not be expected to perform sea-service, for which her design is entirely unsuited.

Since the monitor was invented, the enemy it must meet has become a far more powerful fighting machine than that against which it was originally pitted so effectively. The monitor cannot get so close to the enemy now as before; owing to its slow speed, it must

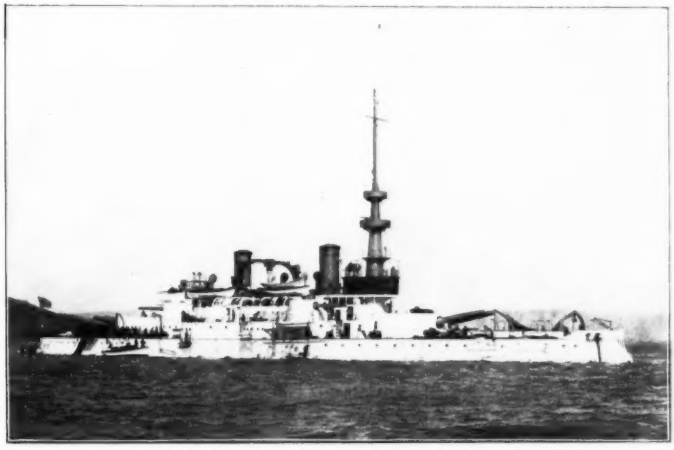
be more on the defensive, and should be fitted accordingly. Besides its big guns, of which it should always have four in two turrets, —all alike, so as to have all the ammunition available,—it should have a large secondary battery of quick-firing guns for defence against torpedo attack, to which a monitor is peculiarly subject.

The four monitors of the Arkansas class, just ordered by the United States government, do not meet expectations as to the main battery, although provided with an excellent secondary battery.

In a fight with a faster ship of equal maneuvering power, the single turret could be kept masked by the superstructure.

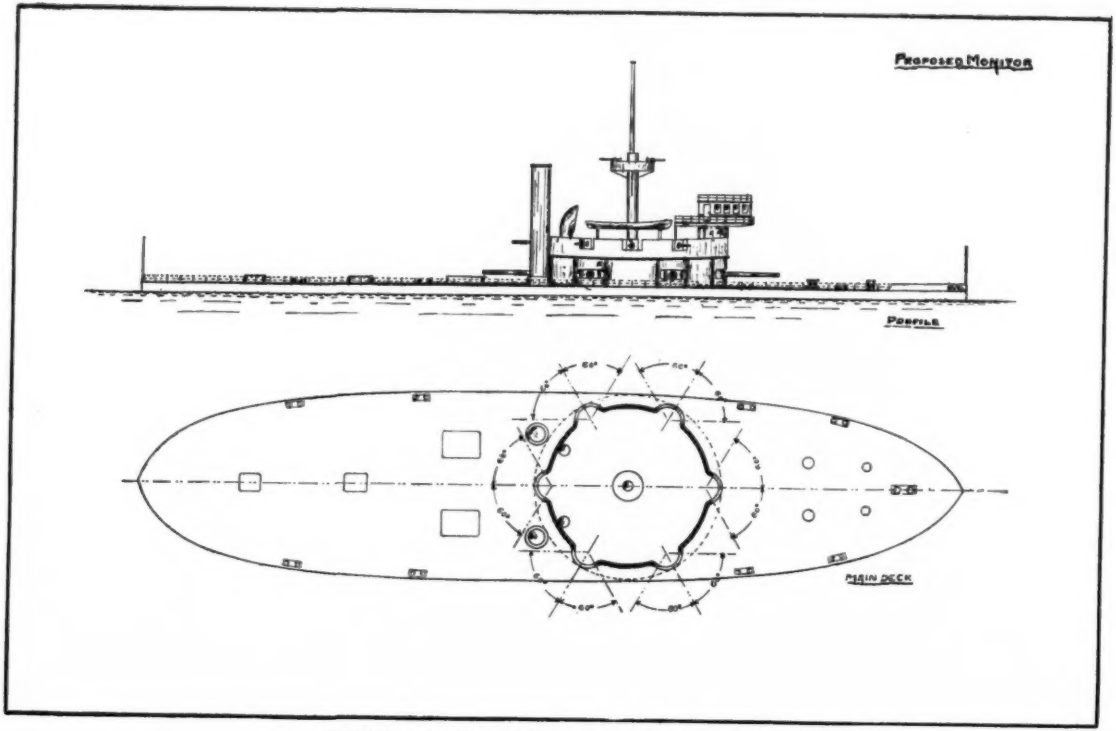
In my opinion, if a single-turreted monitor is built, it should have an all-round train for the turret, all living quarters being under the main deck. In this case the secondary battery could be installed on a platform above the turret, which should be made large enough to mount four 8-inch quick-firing guns, with a small independent train. The platform would have hammock berthing all round, with, say, two 4-inch guns and six 6-pounders.

At this point the question naturally occurs to a designer: Why have a revolving turret at all, with its intricate and delicate mechanism, that admits of fighting from only one side, when a circular redoubt,



U. S. S. OREGON.

10 231 tons, 9,500 h.p., 17.5 knots; 348 x 69.3 x 24 feet; 4 13-inch guns, in pairs, in turrets; 8 8-inch, in pairs, in turrets, 2 on each beam: 4 6-inch quick fire in sponsons; 20 6-pdr. and 6 1-pdr. quick fire; 4 Gatlings; 7 torpedo tubes.

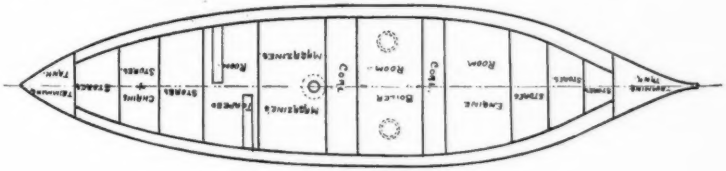


PROPOSED MONITOR, PROFILE AND MAIN-DECK PLAN.

of a diameter nearly equal to the beam of the vessel, would enable at least two guns to be directed on one object, while at the same time other guns could be turned on other objects, and the superstructure would be a fixed platform, enabling each gun to be worked independently.

On these lines I have worked out a scheme that enables a battery of six 8-inch quick-firing guns to be effectively mounted, the barbette being 50 feet in diameter, and the upper platform 58 feet, which gives room for ten 6-pounders. The magazines would be located forward of the coal bunkers, the ammunition being served by endless chains worked by electric motors. The arrangement would be somewhat similar to that shown in the sketch plans (Figs. 1, 2 and 3). In such a vessel the danger of damage to the turret-turning gear is eliminated, and each gun is independent of its neighbor.

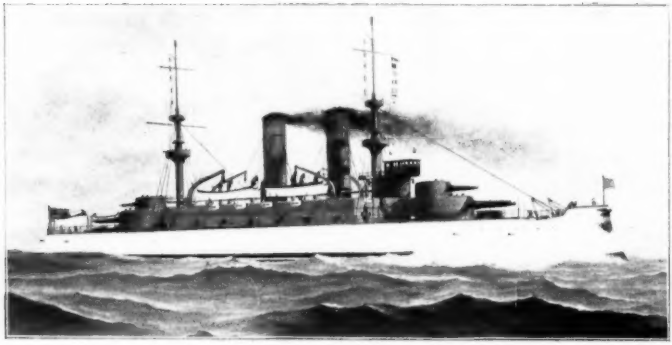
A vessel having the revolving turret as its distinctive feature, while coming under the class or type to which the monitor belongs, would hardly be accepted in the United States as a monitor. Yet, I think, if the type is to be retained it will undergo some such modification.



PROPOSED MONITOR. HOLD PLAN.

As the natural weapon for attack on the monitor is the torpedo, I have thought it strange that the monitor has not been fitted with means of defence against this attack, or with any means of returning it. There is no difficulty in fitting a monitor with submerged torpedo tubes, and it appears to me that, in its special function of harbor and coast defence, it would have more and better opportunities to use them than battle-ships or cruisers would have. I therefore show two submerged torpedo tubes fitted directly on the inner bottom forward of the magazines. The center line of these tubes would be about nine feet below the surface of the water; although not quite as deep as such tubes are in battle-ships, they are certainly within the limits of effective working, and would be a great addition to the monitor's offensive power.

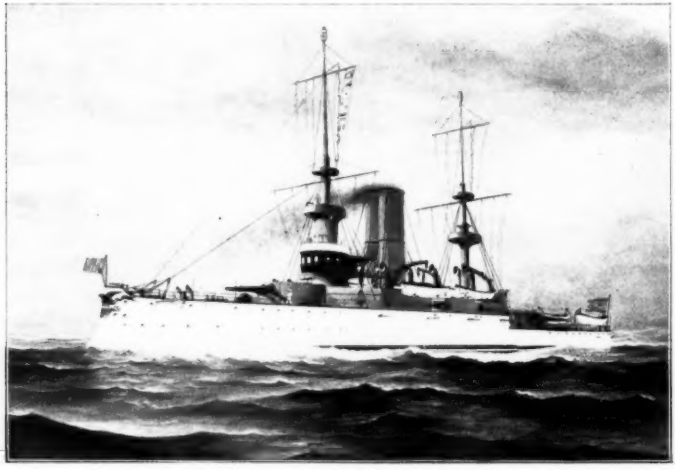
I have already devoted more space to the monitor than its comparative importance warrants. Yet, if it is possible to preserve the



U. S. S. KENTUCKY.

11,500 tons, 10,000 h.p., 16 knots. Dimensions practically the same as the Illinois. 4 13-inch and 4 8-inch guns, in pairs, in superposed turrets; 14 5-inch quick fire; 20 6-pdr. and 6 1 pdr. quick fire; 4 machine guns; 5 torpedo tubes.

good qualities that undoubtedly belong to the monitor, and to add other qualities that will enable it to act as a coast-defence vessel, where voyages of considerable duration must be made at sea,—sometimes a



U. S. S. ILLINOIS.

11,525 tons, 10,000 h.p., 16 knots; 368 x 72 x 23.6 feet; 4 13-inch guns, in pairs, in turrets; 14 6-inch quick fire; 17 6-pdr., 6 1-pdr. quick fire; 4 machine guns; 4 torpedo tubes.

necessity, especially on the western coast of the United States,—such a type of vessel will be able to do work that now requires a battle-ship or armored cruiser.

At the same time, it must be admitted that the battle-ship or armored cruiser can accomplish much that the monitor cannot, and this fact will limit the application of the monitor type, no matter how modified, to harbor and coast defence, its principal limitations being the extremely low freeboard which limits the speed, and the small coal-capacity.

BATTLE-SHIPS.—This type of vessel in its various modifications, notwithstanding the many predictions that new instruments of attack would render it worse than useless, is still the backbone of all the great navies of the world.

The most noticeable thing at the present time is the narrowing of the difference between the battle-ship and the armored cruiser. The latter, in some cases, now equals the largest battle-ship in displacement, while the latest battle-ships have very nearly the speed of the fastest armored cruisers. The marked increase lately effected in the resistance of armor has enabled the battle-ship designer to decrease the thickness of armor, and spread it over a much larger area. Consequently, the battle-ship has increased in length and in fineness, and with these qualities speeds hitherto thought impossible are now obtained with certainty on the new ships of this class. This advance has been so marked that there appears to be little or no room left for a distinct type of armored cruiser readily distinguishable from the battle-ship.

At present the United States have four first-class battle-ships in commission, and eight in course of construction. The first three, the Indiana, Massachusetts, and Oregon, may be termed low-freeboard battle-ships, as there is no structure above the main deck at the ends, the superstructure extending only between the main turrets.

These ships carry a very heavy main battery, consisting of four 13-inch, eight 8-inch, and four 6-inch guns. Their low freeboard has been commented on as unfitting them for ocean service; yet the Oregon has proved that these ships are not deficient in sea-going qualities. Though they are not as fast as the latest types of this class, the Oregon, built as a 15-knot ship, can respond at any time to an order for 16 knots.

The main turrets of the Oregon are operated by hydraulic power, while in her two sister ships the main turrets are operated by steam. I have not been able to obtain any correct data indicating which

power is most to be depended upon in action. The battle-ships have not yet been tested in an equal contest with ships of the same class, and the Spanish-American war, beyond strengthening the opinion that the first and best thing for a great navy is battle-ships of the highest class, added little to our knowledge of their merits and demerits.

The Iowa followed the first three, and in her the effect of criticism is noticeable. The superstructure extends to the bow, and 12-inch guns replace the 13-inch, the forward turret being above the superstructure deck. This was expected to be, and is regarded as, a sea-going battle-ship, and for comfort in the men's quarters it is better than the three first vessels.

The next two, the Kearsarge and Kentucky, differ from the others in having both main turrets on the main deck; but that deck is higher, relative to the water line, than the decks of vessels of the Oregon class. The main belt is carried to the stem; 13-inch guns are again found in the turrets; four 8-inch guns, instead of eight, and the 8-inch turrets are built on the roof of the 13-inch turrets, and train with them. To train together four guns, all of which are dependent on one piece of intricate machinery, is, I think, a mistake.

In the next three, now being built, the Alabama, Illinois, and Wisconsin, the forward turret has again been raised, the superstructure extending to the bow; the 8-inch guns have been left out, and a battery of 6-inch quick-firing guns has been substituted. The belt armor is carried forward to the stem. The contract speed is 16 knots. It is confidently expected, however, that the speed will be about 17 knots, with one inch air-pressure in the fire rooms.

The last three battle-ships for the United States navy, just contracted for, were to have been constructed from the plans of the Alabama class, but the desire for greater speed induced the navy department to invite builders to tender for 18 knots instead of 16, as intended. These ships, therefore, will be twenty feet longer than the Alabama, and will have a power exceeding the Alabama's by about 3,000 horse.

Owing to the light draught of water,—light as compared with that of British battle-ships, 23½ feet normal,—the new United States battle-ships will not have so fine lines, and therefore must have greater power to obtain the speed required. The dimensions fixed upon are: 388 feet long; 72 feet beam; draught of water at 12,500 tons displacement, 23 feet 8½ inches. They will be the first of the United States ships to have submerged torpedo tubes. They are to

carry one thousand tons of coal on their normal displacement, and have bunker capacity for two thousand tons.

As a result of experience gained during the late war, wood is to be used as little as possible, and, where used, it is to be subjected to the treatment known as the electric fire-proofing process. There is no doubt that the substitution of light corrugated steel for wood in all partitions and bulkheads in living quarters gives to these rooms a prison-like appearance that is anything but comfortable. But the need of a better material for this purpose will in time produce it. Boards made from pulp that is thoroughly fire-proofed and stamped into artistic shape will, no doubt, soon take the place of corrugated-steel plate, and fire-proof rooms be as attractive as those of wood.

The most needed improvement on war-ships at present is simpler mechanism for all purposes that require power. Since I have had to do with the getting out of machinery adapted to the many and varied requirements on these vessels, I have never missed an opportunity to advocate greater simplicity and directness in applying the power to the work to be done. Shipbuilding and naval traditions are the strongest obstacles to be overcome in attempts to improve in the direction of simplicity. The war-ship is a growth, and, while new methods are invented for certain purposes and adopted, the old methods are still retained, until in some ships we find several ways of doing the same thing, all adding to the general complication.

The firm with which I am connected is just finishing a war-ship for the Japanese navy. It is lighted by electricity. The generators are in triplicate, to insure against failure, and the wiring is divided into several circuits, so that only a portion of the lights would be extinguished in case of failure in transmission. Yet, after all that care, oil-lamps must be fitted wherever light is required, and, lest there should be no oil in the lamps, three hundred candle-sticks must be furnished.

While this question of simplicity is a general one, and applies to all classes of naval ships, yet I may state here in what way I would simplify battle-ship operations requiring power.

Owing to the divided responsibility in the construction of war-ships, the design partakes largely of the methods favored by the various bureaus that control certain parts of the work, and therefore a homogeneous whole cannot be expected.

In the important matter of power-transmission I do not know of a single ship in which one mode of transmission has been adopted throughout the ship. Steam pipes, water pipes, and electric wires are

still run side by side from end to end of the ship, where one would answer all purposes. While I have been a strong advocate of hydraulic power-transmission on war-ships, there are so many operations in which electric transmission seems to meet the conditions more directly that I now think we are fast reaching a stage of development in the application of this subtle agent, which will render it the best means by which to operate all mechanism requiring power on board war-ships. The use of only one means of transmitting power on a given ship would be a great step in the direction of simplicity.

In nature we find that living organisms, when they have no further use for an organ that played an important part in the life of their ancestors, have the means of suppressing, or blotting out, as it were, the useless organ. But shipbuilders carry along a lot of appendages hardly ever used at the present day. The old sailing ship of the line required an efficient system of hand, fire, and bilge pumps, so arranged that men could work at them. Now we have an elaborate system of steam pumps for drainage and fire purposes, and yet the old hand pumps are fitted with their long cranks and many valves and connections to manifolds, although never used except in tests of their condition.

The whole drainage system on these ships has been a growth, and, in consequence, needs to be freed from the many appendages that have outlived their usefulness. I see no reason why a main drain should not be provided in the construction of the hull, by having two vertical keel plates instead of one, the space between being the main drain well, extending from end to end of the ship. All compartments would drain into this well through valves controlled from the deck, and the pumps would draw directly from it.

Another complication is ventilation and heating. These matters, in the United States navy, are under separate bureaus, the ventilation coming under the head of construction, and the heating under that of engineering. The heating system is a source of great trouble. The large amount of piping and the many fittings render it very difficult to prevent leaks. Now, with artificial ventilation as carried out for all living spaces on war-ships, it would be a very simple thing to have each ventilating fan or blower deliver through a heater box fitted with the proper amount of steam-pipe surface, thus heating the fresh air to be sent through the living spaces, instead of running the hot steam pipes all over the ship.

Where new methods of operating are adopted, they should always be reliable enough to displace the old methods, instead of being added

to them, as usual. I have never seen a telemeter, for instance, applied to operating the valve mechanism of a steering gear, that replaced the appliances already in use for the same purpose.

In the enginering department the same duplication of methods for accomplishing a given purpose prevails. The only thing remaining for which but one method of operating is provided is that of turning the propeller, which has come to be apparently of less importance than the question of how to handle feed-water pumps, fire pumps, filters, heaters and the numerous accessories pertaining to what used to be considered secondary matters.

If the whole auxiliary system were blotted out and a fresh start made with the simple purpose of meeting all requirements as simply and directly as possible, much of the present complication could be avoided. There should be a pumping compartment, with the most economical pumping plant in duplicate for feed-water, its function to be that of taking feed-water from the feed tank, and delivering it into a feed main at a pressure sufficiently above the boiler pressure to make the feed absolutely sure. A loaded valve on this pipe would return the surplus to the feed tank. The attendant would regulate the speed of this pumping engine by the flow from the surplus valve. A bilge and fire pumping engine in duplicate would also be in the same compartment. A set of low-pressure pumps would also be required for water service, sanitary service, and circulation in auxiliary condensers and distillers. Main bearings, guides, etc., that have closed water circulation for keeping the parts cool, should discharge into the sanitary tanks overboard. The present plan of having them open to the bilge involves much pumping.

The great mass of pipes, valves, and manifolds, now fitted always in duplicate, and often in quadruplicate, is often more a source of danger than of safety. They are now made with little margin of strength. A small amount of wear or corrosion puts them out of service, and usually the duplicate is in the same condition as the original. If seventy-five per cent. of the material now put in duplicate pipe systems were put in one substantial arrangement, there would be less liability to derangement, and only one-half the stuff to care for. I am satisfiged that one-half the piping and valves could be removed from the engine and boiler compartments of our war-ships, in accordance with a plan that would increase their efficiency, reliability, and safety. It only requires that the traditions of the service be laid aside, and a new start made on common-sense principles.

In the change that is taking place in the type of boiler used on

war-ships, the usual conservatism in regard to naval practice has been cast aside; where it was hardly possible with the Scotch boiler for the engineer to obtain space enough to install the boilers as to get the very best result, the water-tube boiler now demands practically the whole ship under the protective deck. The argument in favor of this type of boiler—that it is lighter than the Scotch for a given power (I refer to boilers of the Belleville type)—has been given up for another that may have more foundation in fact,—viz., the possibility of making repairs without opening the decks of the vessels. It has been customary to install Scotch boilers in war-ships without regard to convenience in the matter of repairs. I have seen air shafts built over fire rooms not large enough to permit the passage of a furnace, when an inch or two more would have made the removal of a furnace as easy as on a merchant vessel.

The contention that Scotch boilers would not stand forced draught has been settled by the fact that a large proportion of merchant steamers now use forced draught constantly, making continuous records of more than 20 h. p. per foot of grate, while in war-ships such a record is about the best reached for a trial of a few hours, and it was considered a great success if the boilers were not injured in doing it.

It is not yet time to claim that the water-tube boiler in any of the many form now in use is to be the boiler for war-ships of the future. The question of endurance under unfavorable conditions has yet to be decided, as also the question of fuel economy.

As it stands to-day, the navy department of the United States stands committed to a trial, on a grand scale, of the water-tube boiler on battle-ships. This will have the effect of lengthening the ships, as a form of water-tube boiler suited for sea service cannot be installed in the space that accommodates the Scotch boiler, while more room must be given to evaporators for the production of fresh water, and more again to storage of the water thus produced. Skill that may be acquired in the management of water-tube boilers may reduce the work for evaporators, and thus save fuel used for that purpose.

The small amount of water in the boilers to take up and give out heat as the fire temperature varies is the principal cause of difficulty—to be overcome only by the skill and vigilance of those in charge.

That the water-tube boiler has made little progress in the merchant service, where econmy in fuel and in operating expenses is more closely watched than in the navy, need not be taken as an argument against its use in the navy, there being other factors than expense that may outweigh all economic considerations.

MACHINE-SHOP MANAGEMENT IN EUROPE AND AMERICA.

By H. F. L. Orcutt.

IV.—COMMERCIAL ORGANIZATION AND SALES MANAGEMENT.

THE commercial management of a machine shop is so closely connected with its mechanical success, or failure, that a consideration of this side of the question is necessary for an appreciation of the relative conditions of European and American machine-tool work. The peculiar condition of the European market is of special interest to European makers who are endeavouring to keep abreast with the times, and to American makers, many of whom have recently enlarged their works solely on the strength of their increasing foreign trade. American and European methods differ as widely commercially as they do mechanically. It is my object to contrast some of these, as well as to outline briefly the situation with reference to the European market for machine tools.

In the machine-tool business, as in others, a successful commercial policy must harmonize with economic demands and the industrial situation. Economy demands specialization of plant and concentration of ability, which must be devoted to production in a particular line. The industrial situation is such that the days of cheap machinery (that is, machinery of really bad quality and primitive design) are numbered. As the "machine-made" takes the place of the "hand-made" article, machinery must become capable of turning out a more highly-finished and perfect product; this cannot be done by cheap machinery. The commercial policy of the modern machine shop, then, must be dictated mainly by two conditions,—specialization and good quality. With few exceptions, American manufacturers recognize specialization as an absolute necessity to commercial success; it is also adhered to by many European manufacturers, but, as makers of machine tools, it is not adopted by them in a single instance, though they recognize it as an essential to success in nearly every business but their own. The size of the machine that most European makers will undertake to build seems to be limited only by the height and width of their workshops, and the variety only by their ability to get orders. There is, relatively, far more cheap machinery made in Europe than in America. Most American manufacturers will take

orders for only such machinery as they are specially fitted, by experience and equipment, to make. This principle is the keynote of their success in the European market. It is strictly adhered to by those who are at the front, it is not followed by those who are, admittedly, dropping behind, and it must be, sooner or later, adopted by all.

The commercial advantages possessed by the specialists, in comparison with the makers of varieties, are many. First and foremost is the fact that they can, almost invariably, offer a machine that will pay their customers far more interest on the investment than the makers of varieties can show. Devoting themselves to only one line, they can always lead in the production of machinery that will save labour, do good work, and be well made. As the whole energies of their staff, and their entire factory equipment, are devoted to the production of one article, they can always sell for the lowest price, and, as they usually make in quantities for stock, quick deliveries can be made. Known as specialists, they are frequently, and preferably, sought by purchasers. Having had, within the last few years, a great deal to do with the ordering of large quantities of machinery, I have found the maker of specialties invaluable as a consulting engineer, with reference not only to his own product, but also to the products of makers in other lines. My experience has been the opposite with makers of large varieties, from whom comparatively little can be learnt which does not pertain strictly to their own work. The commercial success of the American specialist in Europe is already assured; he can meet competitors in every respect, and can offer machinery that turns out a greater product, cheaper, better made, and more quickly delivered, than the European maker usually produces.

In America competitive specialization has, undoubtedly, assisted largely in developing many of the handy movements and labour-saving devices which are common to the American machines, but, as a rule, lacking in the European article. Other important commercial advantages are connected with the American system of specializing; manufacturing is simplified, office expenses are lower, and exact cost-keeping is easily carried out. All of these assist to produce an article which, in price and quality, defies competition on the part of makers of large varieties. Machines are made for stock, not to order. Some makers even store machines in boxes ready for shipment. It is one of the vexations of the machine-tool business that customers put off ordering until the last minute. Having once decided, however, time of delivery often determines where the order is to be placed. Even machines of special dimensions—like lathes of extra length—

can be delivered in from two to three weeks, as makers who are devoting themselves to a single line keep in stock a large number of standard parts, such as headstocks, tailstocks, and carriages, so that the order for a special length of bed merely means casting and finishing the bed itself. As far as I have seen, this method is carried out in only a few instances by European makers of machinery, and then in but a comparatively small way.

In their methods of securing business, the American manufacturers of machinery have as little veneration for time-worn customs as respect for old-fashioned machinery. The best of them advertise their wares in the leading technical journals in a manner which many European machine-tool makers would not think it possible to adopt without sacrifice of their so-called "respectability." The fetich, "professional etiquette," which still so largely influences the conservative European manufacturer, does not exist to the maker of machinery on the western shore of the Atlantic. The American never sits at home, waiting for orders to come to him. Unlike many European makers of machinery, he has no clientele to stick to him, regardless of improved designs and quicker-acting machinery developed by others. He takes the fullest advantage of all avenues open for advertising his machinery, and for bringing it before the public. His representatives are usually practical men who have had shop experience, and can intelligently advise as to the application of new methods. Mention has already been made of the manner in which the American manufacturer uses the machine-tool maker as a consulting engineer.

On the other hand, I find it a complaint, among large European buyers of American machinery, that the European maker takes little trouble to bring the merits of his goods before purchasers, or to employ suitable men, trained as engineers, to deal with customers. The qualifications which the American machine-tool maker possesses are highly appreciated by European purchasers. Usually sticking to one line, he has no object whatever in concealing any knowledge he may have respecting other makers, and he will generally freely advise as to machinery made by others. Specialization works commercially, as well as mechanically, to the advantage of all concerned.

Speaking of specialties, I am reminded of one that is peculiarly European; I mean "tipping." The American machine-tool maker is free to secure business on the merits of his goods, rather than on the commissions which he can offer to foremen and works managers. But the extent to which "tipping" is carried on among European manufacturers is, I think, a serious drawback to all concerned.

The success of a machine tool of ordinary or special design is too often dependent upon the commission secured by the foreman, or upon the liberality with which Christmas boxes are distributed. This latter is a form of bribery accepted to a surprising extent.

Although there are exceptional cases on both sides, it may be said that American managers and proprietors of machine shops are harder working, more practically trained, and more thorough masters of details than men in the same positions in European establishments. Many of the best European machine shops are governed by thorough engineers. In some cases where they admit points of superiority in American practice, they do not adopt them for the reason that manufacturers and workmen still demand out-of-date designs and old-fashioned appliances. Moreover, English machine-tool practice is largely influenced by government stipulations, which are rarely "up to date," and by a large foreign trade which, up to the present, has been encroached upon to a comparatively small extent by other nationalities. The American manager works longer, and thinks less of his holidays, than the European. The shooting season and the watering place interfere but little with his business application. I am acquainted with a number of managers of American machine shops of wide reputation who can be found in the works every morning at seven o'clock. They are closely in touch with their foremen and workmen, and associate with them on a more friendly and familiar basis than is possible in a European shop. With few exceptions, the managers of the leading machine-tool works of the United States are successful mechanics and at the same time good business men. This would hardly be true, as a general statement, with reference to European machine-shop managers.

The management of technical affairs by commercial directors who have little or no knowledge of the business they control is of rare occurrence among American manufacturers, although there are several well-known exceptions in the United States among makers of machinery. Every engineer who has attempted to work under management of this kind must realize the great disadvantage under which such companies work, in comparison with corporations conducted by thoroughly practical men. The military systems of continental Europe have developed a peculiar mania for bureaucratic management in manufacturing establishments. This is a curious fact, as European armies are striking examples of what can be accomplished by the combination of the theoretical and practical. In the army, however, command must be in the hands of those who

are thoroughly trained in every detail of the profession, and have had experience in every department. In Germany mechanical development is, in many cases, largely directed by technically-trained men, who are crammed with book knowledge, but have little or no practical experience The conditions under which American machinery has been developed, and against which they must compete, these men little understand. To this ignorance on the part of so-called commercial and technical directors, which is so prevalent in Germany, is the inefficiency of the labour which they control largely due. German workmen are capable of doing the finest mechanical work. Americans are still sending to Germany for the best optical and microscopic instruments, for the most delicate levels and accurate graduating. Capability is not wanting, but the large body of mechanical workers is spoiled by mismanagement and bad supervision. Incompetent technical superintendents hold positions, secured through influence by commercial directors who have no knowledge of mechanical requirements or of the industrial situation, and have, moreover, no appreciation of practical results, good, bad, or indifferent. The result is that generally a low standard exists as regards the quality of manufactured articles, and, as it is considered a correct commercial principle that low wages are the cheapest, high-grade workmanship is not rewarded and consequently not developed.

As far as economic conditions are concerned, the American proprietor has no better understanding of the problem than the European,—probably not as good,—but, from a business standpoint, the American knows the value in dollars and cents of the high-wage-earning, thoroughly-trained mechanic. The machine-tool business is almost wholly controlled by those who appreciate high-grade work and proper organization. This is also partly true of England, whose standard of workmanship is below the American, but above the German. The situation in Germany is peculiar, as the present industrial activity is largely promoted by wealthy banking houses, which, without thoroughly understanding the industrial problem, know that there is a demand for a certain article, and that by investing so much capital such and such dividends are possible. Vast sums are available for founding new factories built by those whose sole occupation is the amassing of money and investing for clients. Such men, whether German, American, or of any other nationality, have little comprehension of engineering requirements or appreciation of engineering ability. Engineering talent is looked upon by them as any other commodity which can be bought for a certain price. Com-

mercial engineering is, however, more commonly understood in America than in Europe; that is, the advice of engineers in commercial matters is more frequently sought and followed there.

The low standard of workmanship common in Germany promotes the cultivation of peculiar commercial principles. In manufacturing the tendency is to make use of the lowest-paid labour that can be secured; in selling, to dispose of product without sufficiently considering the buyer's requirements, or appreciating the commercial advantages of being in a position to assist him in solving his problems. In America, where the standard of workmanship is high, the opposite conditions are bound to follow. The employment of skilful and highly-efficient labour is necessary. Resort to machine operations, in order to reduce cost of production, is imperative. Reliance on success, and growth of business, are naturally dependent on the reputation made through supplying a superior article. It is a matter of ordinary comment on the part of American manufacturers familiar with German business that they cannot understand how it is possible that so many factories, having out-of-date equipments and employing a low grade of labour, can exist in Germany. Although Germany has many wide-awake, up-to-date manufacturers, she, as a nation, has yet to meet, both in her domestic and foreign trade, the competition of other countries, of whose capabilities she has little comprehension. Capital is not wanting to do this. The progress she is now making in manufacture is evidence of great enterprise. Ability is there. The first essential to Germany's general industrial progress, however, is that she realize her weaknesses, one of the most serious of which is the position which her practical engineers and mechanics occupy, as distinguished from that held by her commercial and scientific workers. In the industrial world there is one class embracing science and commercial management, and another manual labour and executive talent. The two do not fraternize. While there is no brotherly love wasted between workmen and employers in American machine shops, there is, at the same time, practically no social distinction between the bright mechanical worker and the purely scientific or commercial man. There exists an understanding, and an intercourse, which bring the best men to the top in shop management, regardless of educational advantage, or ability to write a scientific treatise or to amass a fortune. The close economical management of works is not carried out in Germany, as it is in America. Actual management is too often directed by those who are appointed to positions of authority on the strength of their supposed commercial

ability, or professional standing, regardless of executive capacity or knowledge of practical details. For the present, this management can succeed in Germany. The demand for material is now excessive, and normal competitive conditions are not yet realized. In many of the newer industries profits are big. As soon, however, as outside competition forces down the price of the article of comparatively better quality, and good work is more commonly procurable, loose technical management must be replaced by a management in which the practical engineer and organization supplant the jobber, professor, and slip-shod factory control. English industrial enterprises are, in some respects, in the same condition as German. In the mechanical world, "Hooleyism" is rampant, but it must have a fall. Its disciples know only "dividends." They are enthusiastic over the fantastic inventions of a mechanical crank, and pass by, on the other side, valuable mechanical improvements.

The salesman of a modern machine-tool company must possess other abilities than the mere knack of persuading people to buy. He must be a combination of a consulting engineer and a good business man. He must have had workshop training, as well as drawing-room and office experience. He must be thoroughly in touch with the works which he represents, know its policy, and be familiar with its progress; otherwise he cannot intelligently advise customers. It is well known that one of the largest and most successful of American machine-tool companies employs as salesmen, in nearly every instance, those who have worked in its own shops. Such men are not only valuable advisers to their customers, but are always alive to criticisms of their own work and to improvements which keep their company abreast with the times. It is a weakness of European engineering establishments that the commercial and technical elements have little sympathy with each other It is a strong point with American makers of machinery that such elements are, in most instances, inseparable. To quote from a recent issue of the "American Machinist:" "a business man may get machinery trade easily enough, but only a mechanic can keep it."

A characteristic peculiar to American makers of machinery is the constant interchange of information, even between sharp competitors. Most manufacturers of machinery are on friendly terms, and I know of several cases where competitors, making the same lines, exchange ideas, and send their workmen to study the methods of their rivals. Shops are usually open to all visitors, and little of that narrow spirit too often shown by European manufacturers exists among American

machine-tool makers. This must, of course, work for the general weal. Improvements in methods of manufacture are quickly adopted by all, and general progress is rapid. It must soon be recognized that it is distinctly against any country or community—or individual, for that matter—to adhere to the principle of closing its factories to anyone. It is a short-sighted policy, and altogether unworthy of an age that prides itself on freedom and progress. An interchange of ideas among those who are working on kindred lines must raise the standard of all. The net result will be a better product, more rapid progress, and, in the end, a larger amount of business.

There is a striking contrast between American machine-shop office management and the sleepy methods in vogue in European factories. No better evidence is necessary to prove the truth of this statement than mention of a few of the office labour-saving devices, all of which have originated in America and are being adopted by many Europeans,—the typewriter, modern letter files, the card index, improved office furniture, time clocks, and recording apparatus. All these save time, simplify methods, and increase accuracy. It would be difficult to find in America a machine shop too small or insignificant to possess a typewriter, a roll-top desk, a swivel office chair, the wooden letter file, and a time-recording apparatus. I have not yet seen the European machine shop office where all the above, every one of which saves time and makes work easier, are in use. The large number of office employees usually connected with the European factory is a matter of comment on the part of Americans. In the office, as in the shop, the same poorly-paid assistants are employed. Low wages, cheap equipments. The dirty and, as a rule, impudent office-lad usually encountered in the English office does not exist in any other country. In Germany clerks, who can be secured in any number for 150 marks per month and, in many cases, can speak and write two or three languages, are commonly employed. The tendency in American machine shops is to make use of highly-developed methods of keeping track of costs, and to have the progress of work supervised by well-paid clerks, and, in many cases, by highly-paid specialists. It is a technical and a commercial necessity to keep exact records of costs and progress of work, by which weak points can be indicated, and wasteful labour spotted. Low costs of production, proper shop organization, and accurate work cannot be accomplished in a factory where office management is out of date, cheap clerks are employed, and old-fashioned methods are in use.

THE MERITS AND PERMANENCY OF THE MASONRY ARCH BRIDGE.

By Albert W. Buel.

WITH the recent tendency toward building more substantial structures has come a renewed interest in that most beautiful class of bridges, the masonry arch. Great progress has marked the art of bridge building since Agrippa built the Pont du Gard 1918 years ago. Spans of 1700 feet already built, and one of more than 3,000 feet to come in the near future, record the advance due to the introduction of steel and refined mathematical analysis. But no bridge of modern times surpasses the Pont du Gard in beauty and grandeur, and it is a safe prediction that it will remain a monument to its builders long after our great modern steel bridges have turned to dust.

The inherent tendency of iron and steel is to return to the condition of ore or oxide from which it was reduced. A piece of steel, unprotected and exposed to the weather, will lose by rust about one quarter of an inch from each surface in one hundred years; or a piece of steel an inch thick will be half eaten away in one century. The present method of protecting metals by paint is so imperfect that it is doubtful whether the best care will succeed in preserving a steel bridge for more than four or five hundred years,—possibly not more than half so long. The average life of iron bridges has been stated to be only forty or fifty years; yet some of the Roman aqueducts have stood for two thousand years, with little or no care.

There are three general types of design under which all bridges may be included,—the girder or truss, the suspension bridge, and the arch. Their distinctive features may be briefly stated. The principal stresses in a girder or truss are both tensile and compressive; in a suspension bridge they are all tensile; in an arch they are all compressive. The direction of the stress exerted by the superstructure on its supports in a girder or truss is vertical; in a suspension bridge it is a pull inclined inward and upward at the anchorages; and in an arch it is a thrust inclined outward and downward on the abutments.

The three classes of material exclusively used in bridge construction are wood, masonry, and iron or steel. On account of the character of the principal stresses, the construction of the main supporting

cables of a suspension bridge is practically limited to iron or steel; for girders or trusses, wood or metal may be employed; but an arch may be built of wood, metal, masonry, or any material, or combination of materials, that can resist compression. The arch alone leaves the designer free to choose the most durable material, and, when built of masonry, it stands for beauty and permanence. The girder or truss is temporary in character, and generally ugly. The suspension bridge may be beautiful, but it is not so permanent; and it is to be regretted that, thirty years after the beautiful Brooklyn Bridge was planned, economical bridge designing should show a result so inferior in aesthetic merit as the design for the new East River Bridge.

The oldest authentic records of bridge construction show the girder type in its most simple form—a beam. The development of the more complex form, the truss, is recent. The only existing examples of suspension bridges are comparatively modern, and the type belongs to the present age. The arch was first used for bridges by the Romans, who brought it to a high state of perfection; but they seem to have applied the principle to other uses long before they built arch bridges. The Cloaca Maxima, or great sewer of Rome, built about 641 B. C., has three concentric rings of voussoirs, and an internal diameter of about fourteen feet. It is still in a good state of preservation.

The principal styles of masonry arches are the semi-circular, the Gothic or pointed, the segmental, and the elliptical.

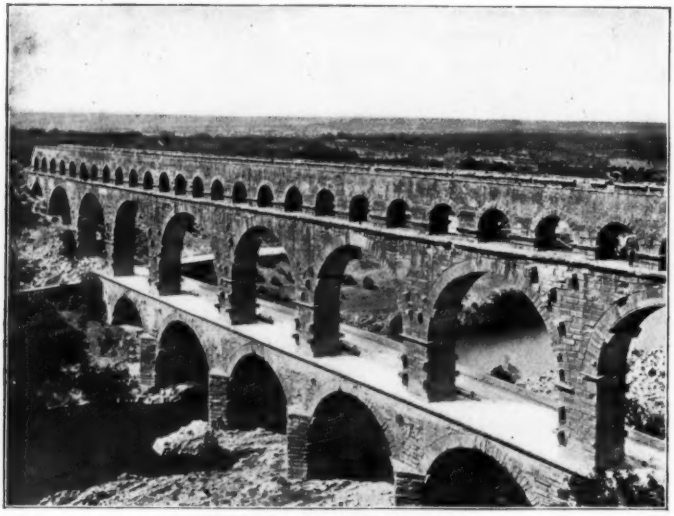
The shape of the arch ring in the semi-circular style is half a circle, while in the segmental it is less than half a circle. The ring of an elliptical arch appears like a flattened half-circle, or as if seen from a point above or below the level of the arch. Masonry arches may be built of ring stones (called voussoirs) fitted together, or of concrete forming a "solid arch" of a single stone, called monolithic. The spandrels are the spaces between the arch ring and the roadway, and the haunches are the part of the arch between the crown and the skewbacks. A skewback is the part of the pier or abutment on which the ring rests and from which it springs.

The Roman arches were invariably semi-circular, and were often built of Pozzuolani concrete faced with stone or brick. The illustration of the Roman aqueduct shows the concrete construction very clearly. The Pont du Gard, at Nimes, France, was built about 19 B. C. by M. Agrippa, son-in-law of the Emperor Augustus. It is 873 feet long and 160 feet high, and has three tiers of arches. The span of the arches in the lower piers is 80 feet 5 inches. The width

CLOACA MAXIMA, ROME.

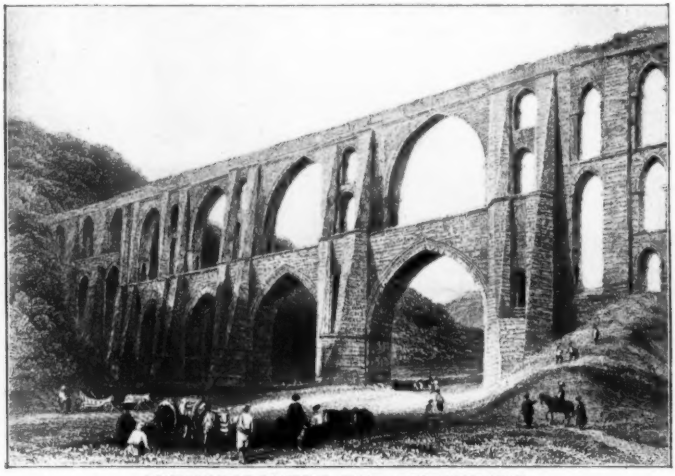
on top is 11 feet 4 inches. In 1743 A. D. the lower tier of arches was widened on one side, as seen in the illustration, to form a roadway.

RUINS OF ROMAN AQUEDUCT, SHOWING BRICK AND STONE WORK.



PONT DU GARD, NIMES, FRANCE.

The Aqueduct of Bourgas, near Constantinople, was built in the sixth century A.D., probably during the reign of Justinian. It has a length of 720 feet and a height of 109 feet. The arches of the lower tier have a span of 52 feet, and those of the upper tier 40 feet.



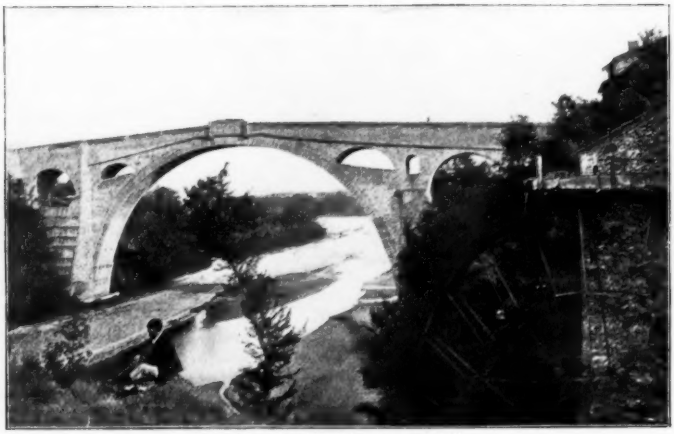
AQUEDUCT OF BOURGAS, NEAR CONSTANTINOPLE.

PONTE DELLA SANTISSIMA TRINITA, FLORENCE, ITALY.

The small arches through the piers tend to relieve the elevation and save material. This is one of the earliest examples of the pointed arch in Europe, the style being taken from the Persians, who probably got it from India. It is poorly adapted to bridge construction, for which it is no longer used.

The Ponte della Santissima Trinita (Holy Trinity Bridge), over

PONT-Y-PRYDD, OVER THE TAFF, WALES

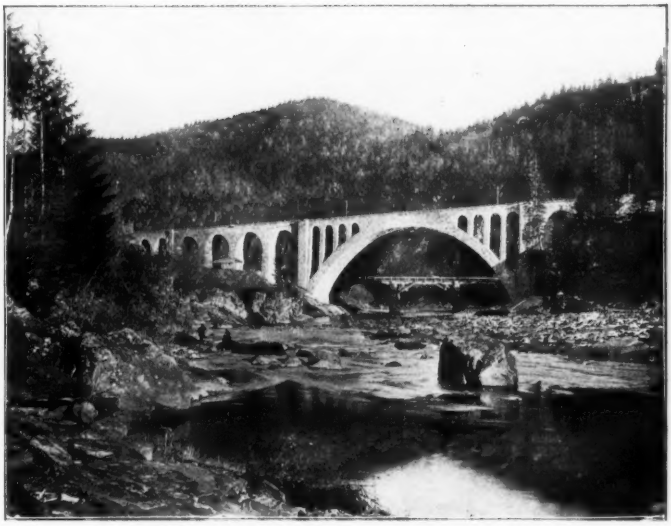


PONT DU CINT, AMIENS, FRANCE.

the Arno, at Florence, Italy, was built in 1569 by B. Ammanati. The very slight point at the crown is concealed by decoration, giving the arches the appearance of being elliptical. The bridge has long been noted for artistic merit. The piers are 26 feet wide, while the three arches have a span of about 95 feet each, with a rise of 14 feet 10 inches.

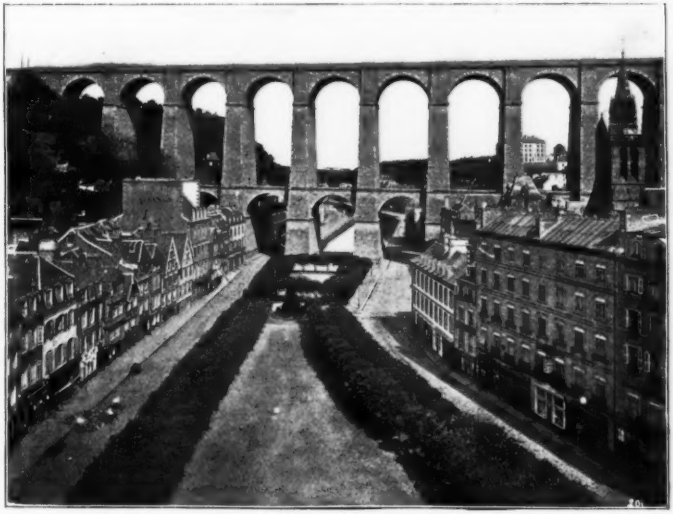
The Pont-y-Prydd, over the river Taff in Wales, was built in 1755

MAIN STREET BRIDGE, WHEELING, W. VA.



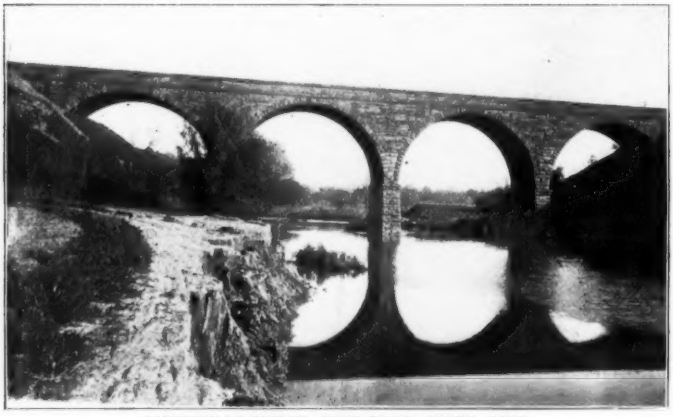
RAILWAY BRIDGE OVER THE PRUTH, JAREMCZE, AUSTRIA.

(The longest masonry span in Europe, 213 feet)



RAILWAY VIADUCT, MORLAIX, FRANCE.

by William Edwards. It is a segmental arch, with a span of 140 feet and a rise of 35 feet. In 1746 Edwards built a bridge of three spans, and contracted to maintain it for a period of years. It was destroyed or washed out in less than two years, and he then built a bridge with a



PAINESVILLE BRIDGE, OVER GRAND RIVER OHIO.

single span, which fell down in 1751, before it was finished. This failure was due to a defect in the design, which he corrected in his third and successful attempt by constructing circular openings in the spandrels, as shown in the illustration, thus reducing the weight over the haunches. Although the expedient was borrowed from the French, the Pont-y-Prydd is a very early example of the use of hollow spandrels.

Another arch with hollow spandrels is illustrated in the Pont du Cint near Amiens, France.

The Main Street bridge at Wheeling, West Virginia, built in 1892, enjoys the distinction of being the second longest masonry arch in America. It has a span of 159 feet, with a rise of 28.4 feet. The exterior spandrel walls are built up solid, but the space between them is open, and divided into several longitudinal vaults, by interior spandrel walls of brick, covered with small transverse brick arches carrying the roadway. The tendency of the transverse arches to push out the exterior spandrel walls at the top is resisted by iron tie-rods. The indeterminate advantage in strength derived from the spandrel walls is more than offset by the deceit in the construction — concealing hollow spandrels behind solid walls. If the spandrels were solid, as they appear to be, the ring would be overloaded. To avoid

offence to aesthetics, the construction should either disclose the hollow spandrels, or the ring should be proportioned to carry solid ones.

The longest masonry arch in the world carrying a railway is in the Jaremcze bridge in Austria, over the river Pruth. It was built in 1892 by M. Ludwig Huss, chief engineer, and has a span of 213 feet, with a rise of 59 feet. The design was developed after the extensive Austrian experiments had been made, and embodies the most approved practice of voussoir arch construction. The hollow spandrels are both scientifically and artistically designed.

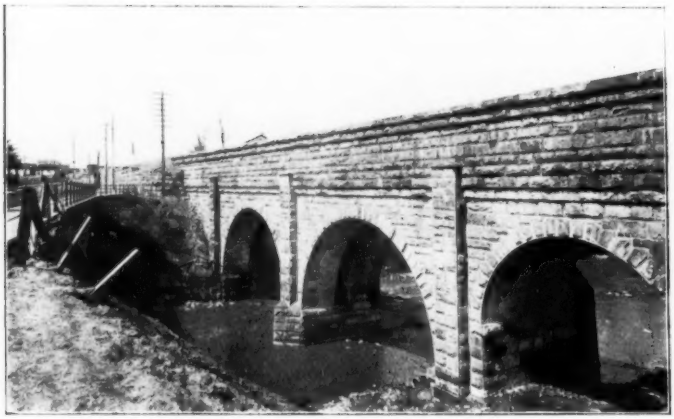
Another European railway viaduct is the one on the Paris & Brest Railroad at Morlaix. It is 934 feet long, and 207 feet high above the quays.

The number of masonry railway bridges in the United States has, until recently, been limited by the demand for cheap and temporary construction. There are, however, a few very good examples. The Painesville arches on the Lake Shore Railway illustrate how much beauty may be obtained by correct proportions, without resorting to ornamentation, which is often inappropriate—not in harmony with either the surroundings or the purpose of the structure. The bridge consists of four semi-circular arches, each of 80 feet span and about 90 feet high, and carries two tracks. Three or five spans would have

STARRUCCA VIADUCT, NEAR SUSQUEHANNA, PA.

been more pleasing, but in other respects the structure is most satisfactory.

The Starrucca viaduct, near Susquehanna, Pa., was built in 1847, to carry a single track of the old broad gauge of the Erie Railroad,



RAILROAD BRIDGE OVER BLACK RIVER, ELYRIA, OHIO.

but without any addition to its width it now accommodates two tracks of standard gauge. It is 1200 feet long and 110 feet high, with spans of 51 feet. A much more pleasing effect would have been produced by semi-circular arches than by the flat arches shown in the illustration. As a general rule, when the height greatly exceeds half the length of the span, semi-circular arches are preferable, not alone on account of appearance, but because the horizontal thrust is less; and, when the piers and abutments are very high, it is desirable to keep the horizontal thrust as low as possible. This is one instance out of many that illustrate the convergence of scientific and aesthetic principles in design; and, as they have not been shown to diverge, it is reasonable to presume that they are always in harmony when truth-

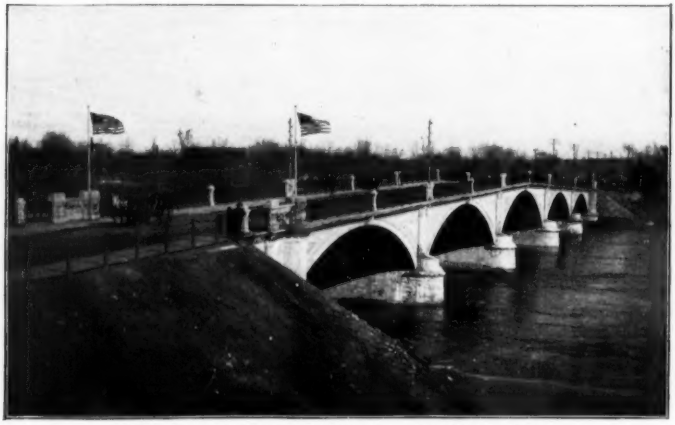
WISSAHICKON BRIDGE, PHILADELPHIA AND READING RAILWAY

MELAN ARCH, EDEN PARK, CINCINNATI, OHIO.

MELAN RAILWAY BRIDGE OVER SOUTHERN BOULEVARD, DETROIT, MICHIGAN.

MELAN ARCH BRIDGE OVER PASSAIC RIVER, PATERSON, N. J.

fully applied. The projecting stones just below the springing line were used to rest the centers on during the construction of the ring, and allowed to remain as supports for scaffolding for future repairs.



MELAN ARCH BRIDGE, KANSAS AVE., TOPEKA, KANSAS.

They are chiefly interesting as being a rare modern example of an almost universal practice with the Romans. Without any material increase in cost, the addition of cornices around the piers at the springing line and a more emphatic demarkation of the horizontal line of the roadway, as in the Painesville bridge, would have been a great improvement.

An arrangement of doubtful economy is shown in the three-span

MELAN HIGHWAY BRIDGE, ROCK RAPIDS, IOWA.

double-track bridge at Elyria, Ohio. Each span is formed of two parallel semi-circular arches about 9 feet wide, with a space of 4 feet 3 inches between them. The masonry is corbeled out to meet at the

TYPICAL STEEL TRUSS HIGHWAY BRIDGE.

top, and carries a solid road-bed about 26 feet wide. The length of the bridge is 234 feet, and each span is 60 feet. The pilasters on the piers have no purpose, and therefore detract from the effectiveness of the structure. Some years after the bridge was built, the tracks were raised about seven feet to improve grades. An equal amount had to be added to the height of the spandrel walls, thus destroying the proportions and giving it a top-heavy appearance.

MELAN ARCH BRIDGE, HYDE-PARK-ON-HUDSON.

The Wissahickon bridge, on the Philadelphia & Reading Railroad, is 510 feet long and 103 feet high above foundations, and has five semi-circular arches of 70 feet span each. It was designed and built in 1881–2, by Mr. C. W. Buchholz, M.A.S C.E., and cost $375,000, or a little less than $3 per horizontal square foot of structure.

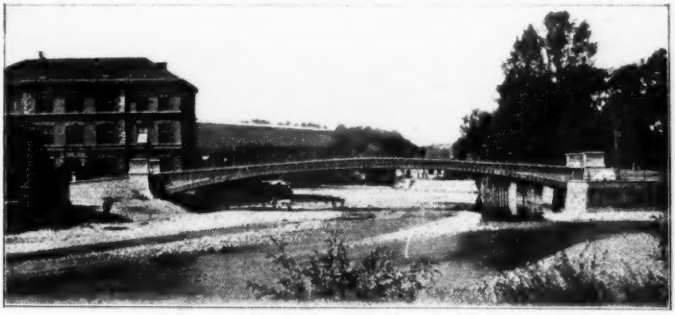
That many iron and steel bridges have been built where all the conditions, physical and economical, favored the masonry arch, is due in part to a lack of confidence in, and appreciation of, its merits, born of defective conflicting theories and approximate methods of analysis. As a result of the recent development and promulgation of methods which compare favorably in exactness and simplicity with those used for a truss, engineers and builders are giving more consideration to

MELAN ARCH IN PARK, STOCKBRIDGE, MASS

the arch. But a more potent agency is the growing demand for better and more permanent construction of roads and bridges, due to the increasing wealth of communities, with the concomitant improvement in taste.

Forty years ago wooden bridges were, with rare exceptions, the only kind built in the United States. With the development of the iron industries, bridges constructed of cast and wrought iron, and a little later, entirely of wrought iron, largely displaced wooden bridges on both railways and highways. During the last fifteen years steel has succeeded in entirely displacing wrought iron, nearly usurping control of the entire field of bridge construction. Until within the last decade, the floors of all these bridges were of wood. The railway-

bridge floor consisted of wooden ties laid on the iron or steel stringers, and the highway-bridge floor of plank, laid usually on wooden joists, sometimes on steel joists. The wooden railway floor was a constant expense to maintain, a source of some danger, and difficult to keep in good surface. Consequently, with more money available and reduced cost of bridge materials, there came a demand for solid-floor bridges. A few railroads revived the construction of masonry arches, but a number of them experimented with steel troughs filled with gravel or stone ballast. The steel plates under the ballast were found to rust so rapidly that in the succeeding plans the ballast was omitted and the rails were laid directly on the steel plates. The indications are that the next step will be in the direction of the masonry arch, for it will be found to be the cheapest structure in the end, when the local conditions do not render it impractical. Steel, however, will retain



THREE-HINGED MELAN ARCH, STEYR, HUNGARY.

the advantage wherever very long spans or maximum headroom underneath are required.

A railway steel girder span 60 feet long, with a solid floor, costs about $1,600. The capitalized cost of maintenance and renewals amounts to about $400, giving a total cost of about $2,000, while the equivalent part of a masonry arch can be built for about $1,800.

With the improved street pavement in cities and macadam roads in the towns and counties, the plank floors of the highway bridges, requiring constant repairs and renewals, presented a feature objectionable to the advocates of good roads, and of greater expense to the communities, not only for maintenance, but also for accidents caused by broken plank. A solid pavement or macadam, to correspond with the other parts of the road, succeeded the plank floor on first-class bridges. The pavement or macadam is laid on a concrete base, under

PONT DE JENA, PARIS. TROCADERO IN DISTANCE.

which there are either brick arches or steel buckled plates, which are, in turn, supported by the steel beams or stringers of the bridge.

PONT DE LA CONCORDE, PARIS.

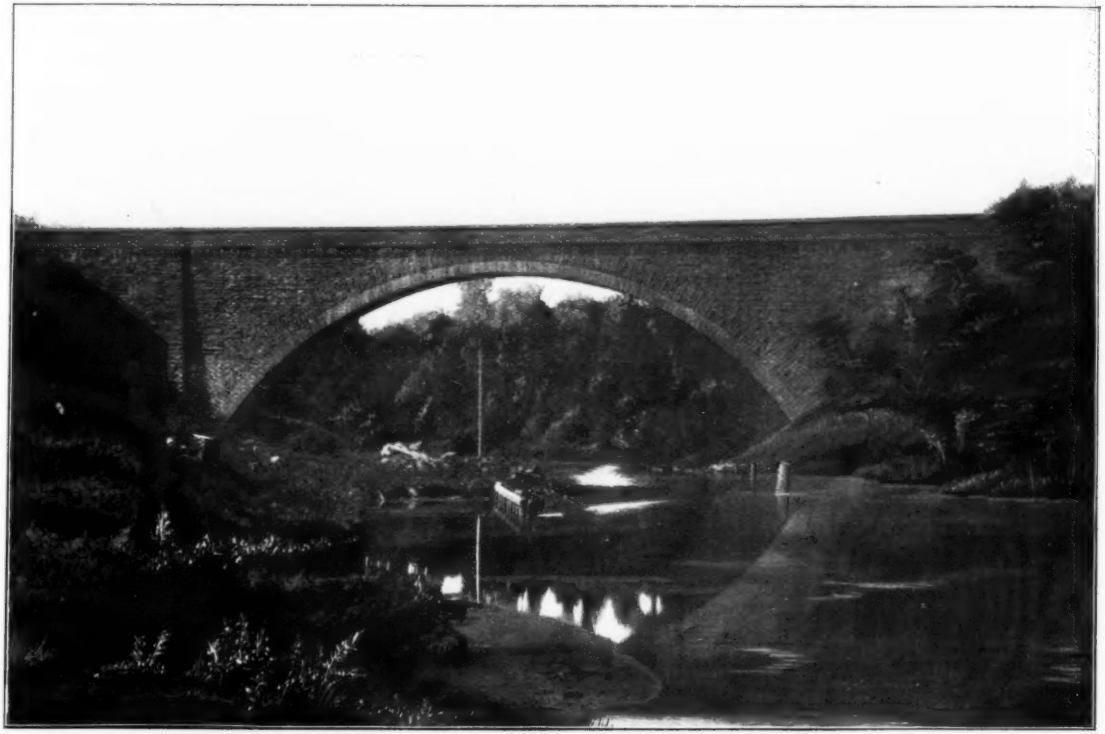
It soon became evident that this construction was nearly as expensive as masonry arches, and in some locations the latter are the cheaper, even in first cost.

The masonry arch has another important advantage over the steel bridge, especially for railways, in the relative ratio of the moving loads to the weight of the structure itself. Except for very long spans, the weight of a steel bridge is small compared with its moving load; consequently any great increase in the loads, over those for which it was designed, overstrains the steel. Many bridges, otherwise perfectly good, have had to be replaced by heavier structures to sustain the greater loads. With the masonry arch, the weight of the

PONT AU CHANGE, BOULEVARD DE SÉBASTOPOL, PARIS.

structure is many times greater than its moving load, and therefore the latter may be doubled without materially increasing the stresses, or seriously overloading the bridge. When these considerations, and the small cost of maintenance, are once fully comprehended by the public, the masonry arch will return to the position it once held as the first of all among the types and classes of bridges; and our landscapes, instead of being defaced with offensive girders and trusses, will be adorned.

One cause of the increased number of masonry arches built in the past few years is the use of concrete, and the perfection of the application to the arch of concrete-steel construction, or concrete re-



CABIN JOHN BRIDGE, NEAR WASHINGTON, D. C., FOR AQUEDUCT AND HIGHWAY.
Span 220 feet; the largest masonry span in the world.

inforced with steel. The favor with which concrete is now received is largely due to the great improvement in quality and reduction in cost of Portland cement. The Romans have bequeathed to us ample evidence of the durability of concrete, even when made of inferior cement. There is also sufficient proof of the absolute protection from corrosion afforded by concrete to steel entirely embedded in it. All the advantages of the voussoir stone arch, and more, are obtained with the solid arch of concrete steel, at a cost nearly as low as that of the solid-floor steel bridge. A number of bridges of this class have been built in the United States, using the system developed by Professor Joseph Melan, which is a direct outgrowth of the Austrian experiments; the system employs stiff steel ribs or beams, embedded in concrete, to form the arch ring.

The Kansas Avenue bridge, at Topeka, is the longest of these. It has five arches, one of 125 feet, two of 110 feet each, and two of 97.5 feet each. The three-centered curve of the intrados was developed by adapting the ring to the requirements of strength and economy. Had a graceful curve been given to the roadway, instead of having the grades meet at an angle, the appearance would have been improved.

The Eden Park bridge in Cincinnati, like the Topeka bridge, is finished in molded concrete. The span of the arch is 70 feet. It has a concrete parapet, and, altogether, is a very artistic structure.

The Southern Boulevard bridge in Detroit, Mich., under a railroad yard, is wide enough to accomodate eight tracks. It is a Melan arch with a span of 50.25 feet, is on a skew, and is 105 feet wide. The face is finished in ashlar masonry, as is also the Melan arch bridge at West street, Paterson, N. J. The latter has three spans of about 89 feet each, and is 50 feet wide. The abutments are on a skew.

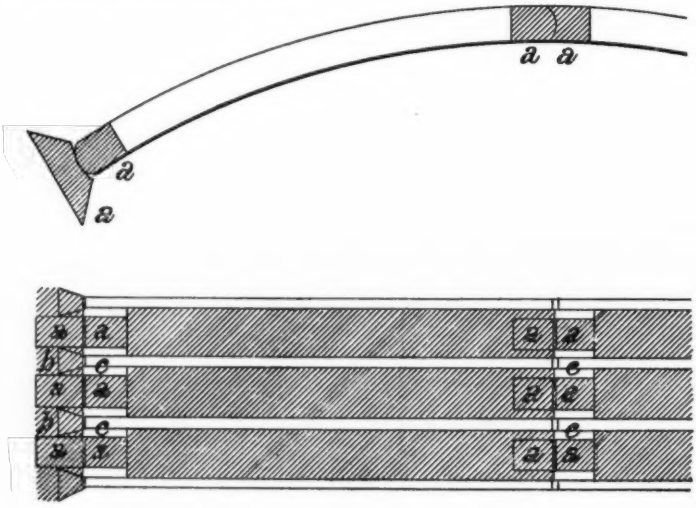
The 30-foot-span Melan arch at Rock Rapids, Iowa, is illustrated with an ordinary steel truss bridge, to show the relative worth of the two types from an aesthetic view-point. Both the arch and the truss were built as cheaply as was consistent with stability, without regard to appearances; but the arch is in harmony with its surroundings and purpose, and looks durable, while the truss lacks both of these merits.

The bridge at Hyde Park-on-the-Hudson, on the private grounds of Mr. F. W. Vanderbilt, is a Melan arch of 75 feet span, with the face finish and balustrade made entirely of molded concrete. The intrados is of five centers, approximating an ellipse.

The Melan arch footpath bridge, in the park at Stockbridge, Mass., has a span of 100 feet with a rise of but 10 feet. The thickness

of the ring at the crown—only 9 inches—indicates what the possibilities are with this system.

In cases where unyielding foundations for the abutments could not be secured, European engineers have resorted to the use of hinges and semi-hinges, which permit of some movement of the abutments without injury to the arch. Hinged arches of iron and steel are very common, but the value of the device as applied to masonry arches has been somewhat exaggerated. In some cases it is the only practical way to overcome the difficulties of securing a proper foundation, but more often other means are available. Where piles can be used, they



HINGE JOINTS IN THE MELAN ARCH AT STEYR.

can be driven alternately vertical and inclined, at little additional cost, thus providing for the horizontal thrust of the arch. It has been suggested that the introduction of hinges simplifies the calculation of the stresses, but the amount of work and trouble saved is relatively small, and should not be a determining factor.

The Melan arch at Steyr, Hungary, has three hinges, at the skewbacks and at the crown. The span is 137.76 feet, and the rise is only a little more than 9 feet, or about one-fifteenth of the span. The extreme flatness of this arch, rendered necessary by the low grade of the street, in connection with the nature of the foundations, made the use of hinges the only practical solution of the problem. The sec-

tional views show the arrangement of the hinges, and also the characteristic Melan system of construction, already described.

In many cities of Europe the memorial bridges are objects of artistic and historical interest. They are generally arches of masonry, almost as enduring as the very ground they spring from. Many of the old Roman aqueduct bridges, enduring evidence of the wisdom and skill of their builders, take their names from, and are memorials of, the emperors under whose orders they were built.

The Pont de Jena in Paris, France, was built under the edict of March 27, 1806, by M. Lamandie. The imperial decree dated January 13, 1807, named it to commemorate the battle of Jena, in which Napoleon crushed the Prussians on October 14, 1806. When the allies occupied Paris, the Prussians threatened to destroy it, but Wellington prevented them from executing their threat, by keeping a British sentry on the bridge. The five segmental arches are 91.75 feet span by 10.75 feet rise, and have 67 voussoirs in each ring. The cornice is 3 feet deep, and the parapets are 3.17 feet high. The width between parapets is about 42 feet.

The Pont de la Concorde is also called the Bridge of Louis XVI. It was built by Perronet between 1787 and 1791 A.D. It also consists of five segmental arches, but is not so beautiful as the Pont de Jena.

Another very beautiful bridge in Paris is the Pont au Change, on the Boulevard de Sebastopol. The present structure was built in 1859, at the cost of about $255,000, and has three elliptical arches of nearly 104 feet span each.

Leaving out of consideration one or two inconsiderable structures, there is not a single masonry arch memorial bridge in the United States. There is only one memorial bridge, and that, being of metal, has a lease of life so short that its purpose as a memorial is defeated. The memorial feature, however, was an afterthought.

For the last fifteen years efforts have been made to secure a memorial bridge over the Potomac, from Observatory Hill in Washington City, to Arlington cemetery in Virginia. At various times three or four official reports have been made on the project by officers of the corps of engineers, and each one has recommended an iron or steel bridge. Three of these reports submitted plans for a bridge with ordinary truss spans, with a draw or swing span in the center, without any artistic merit whatsoever. The estimated cost of such a structure is now placed at nearly $1,500,000. One plan contemplated a series of steel arches, while another called for a suspension bridge with

masonry arch approaches. The latter could, no doubt, be so designed as to present a very graceful appearance, but its cost was estimated at $3,500,000, which is more than sufficient to provide for a permanent high-level structure of masonry arches.

These official reports have all stated that masonry arches would be of shorter spans, and would therefore require more piers in the river than a steel bridge. Each then recommends a steel bridge with spans of only 300 feet.

General Meigs built the Cabin John aqueduct and highway bridge near Washington forty years ago. It is the longest masonry arch in the world, having a span of 220 feet. The bridge over the Adda, near Trezzo, Italy, built by order of Visconti in 1380, and destroyed by Carmagnola in 1416, had a span of 251 feet with a rise of 88 feet, and a total thickness of ring of only 4 feet. The Romans built spans of 140 feet nearly two thousand years ago. American contractors have offered to build and guarantee voussoir spans as long as 280 feet, and in one case a solid arch of masonry of 300 feet span.

That an arch of 400 feet span is no more difficult to-day than the spans just mentioned were in their day can be demonstrated; but with the recently perfected methods of analysis, and improvements in materials and facilities, the construction of an arch of 300 feet span is lacking in all the elements of daring that attended the early undertakings.

In that center of historic interest, the capital of the United States, with the Washington monument, the executive buildings, and the new Potomac park on one side, and the beautiful Arlington cemetery on the other, no bridge but a masonry arch would be a fitting memorial to America's national heroes. It is to be hoped that this opportunity for the government at Washington to set an example for municipalities to follow, in building really permanent and aesthetic structures,—a true index of the state of progress in the constructive arts,—will not be lightly thrown away by the erection of a hideous truss bridge.

COMMERCIAL ASPECT OF ELECTRIC TRACTION IN GREAT BRITAIN.

By Emile Garcke.

THE scientific principles underlying the superiority of electric traction for the propulsion of tram-cars are practically the same all the world over. It is when we consider the commercial and legal aspects of the question that we find some explanation why this superiority is not manifested in the same degree, under apparently like conditions, in different countries.

One of the fundamental advantages possessed by the overhead system of electric traction is that the power is generated for all the cars at one or more central points, and is distributed over the entire system and expended at the points where the traffic requires it and in proportion to the volume of the traffic to be carried; while in the case of either horses or steam, and also in the case of the self-contained electric-accumulator car, and some other systems, each car requires to be accompanied, for the whole of its journey, by its own motive power, which must be sufficient to start the car and to carry the maximum load of passengers, and must be able to overcome the steepest gradient. As the abnormal demand for power for these purposes is only occasional in time and place, it follows that there is considerable waste when the car is empty, or on the level, or at rest. Moreover, in the case of horse traction, about four-fifths of the horses required for the cars are resting or feeding, while the work is being done by the other one-fifth, and the service of cars cannot be increased to meet an exceptional demand without permanently providing this wasteful margin of power.

Now, in the case of electric traction, if the traffic calls for a more frequent service, it can be provided without very largely increasing the working expenses. Of course additional capital expenditure has to be incurred to furnish more cars and other plant, but a much smaller increase of traffic will justify the running of an additional car, with the overhead system of electric traction, than in the case of other systems.

Many of the other advantages of electric traction, such as avoiding the objections arising out of the employment of horses or steam locomotives in the streets, are too obvious to call for mention; and the

many engineering or technical benefits surrounding the use of electricity for the purposes of traction are not within the scope of this article. Suffice it to say that the net result of the adoption of electricity for tramways is not only that, up to a certain point, an ever-increasing traffic can be carried at a relatively less cost of working; but this very fact tends to produce the increased traffic. It is a case of the supply creating the demand. An improved and quicker service encourages people to patronize tramways who otherwise would never think of traveling in tramway cars. In fact, the basic argument for the adoption of electric traction is that it creates passenger traffic which at present does not exist. Without any increase in population, more people are carried by electric tramway cars than formerly by horse or steam cars; and this without in any way detracting from the traffic on the ordinary railroads, except in the case of purely urban or suburban lines. Electric cars are intended for people who at present either walk or do not move about. They serve the busy man who goes from house to house—not from station to station—because he is unable to resist the temptation of entering an attractive-looking, well-equipped, and well-lighted car which stops and starts quickly, picks him up wherever he is without his waiting for it, and puts him down wherever he wants to be.

Hence, electric tramways are in every sense popular. They do not depreciate properties, but on the contrary, they improve the character of the district they pass through; properties appreciate in value and extensions of the tramways are invariably called for; whereas, in the case of the old forms of tramway, every extension was strongly resisted.

Provided an electric tramway system is extended on judicious and sound commercial principles, then, the larger the system, the lower will be the proportion of working expenses to the total receipts, and the better will be the percentage of profit on capital expended.

This, in general terms, accounts for the fact that tramway companies, which formerly could not keep their heads above water, are able to make profits on largely increased capital. It is, however, this enormous increase of capital inseparable from the adoption of electric traction which gives rise to all the difficulties. The fullest advantage of electric traction and the greatest possible reduction in working cost can only be secured by an enormous capital outlay and it is in this phase of the problem that investors in electrical-tramway undertakings are exposed to the greatest danger, because the optimism produced by the first success may lead those who are inexperi-

enced in the business to make extensions of a kind which may have the effect of neutralizing, instead of increasing, profits.

The advantages of electric traction were fully recognized by street-railway men in America some ten or eleven years ago, and were forthwith realized to such an extent that, whereas, in 1890 there were 5,400 miles of tramways (or "street railways") worked by horses, there are now only a few hundred miles so worked, and horse traction is rapidly disappearing altogether, while there are now, probably, not less than 20,000 miles of street railways worked by electricity in America.

In 1887 there were, in the State of Massachusetts, 470 miles of tramways, all operated by horses. There were, in 1896, over 1,080 miles of track, all but 62 miles of which were equipped for electric power. That is to say, in the State of Massachusetts, with an area and a population only about one-fifteenth of the United Kingdom, there were more electrical tramways than there were tramways of all descriptions in the United Kingdom.

When the success of this system had been demonstrated in the United States, engineers in Europe also turned their attention to the subject; and on the continent, people were not slow to avail themselves of its benefits. But in England there has been, until quite recently, a tardiness to adopt the new form of locomotion, the reason for which cannot be obvious to those who have not been engaged in the struggle to overcome the difficulties and obstacles which have existed and which have given rise to a condition of things which may even now divert the development of the industry into wrong directions, and make progress less desirable than stagnation.

On this point it is interesting to have the testimony of so well informed and impartial an authority as the special committee appointed by the State of Massachusetts to investigate the relations between cities and street-railway companies in America and elsewhere. They state, in their report of February, 1898, that in America grants to use the public highways have been given entirely without adequate protection to the interests of the town, the officials thinking only of the benefits to be derived by the people from being placed in close communication with some neighbouring town or city; while in Europe the rigid restrictions imposed on companies desiring to use the streets for tramways "have restricted technical development to such a degree that it may be said that there scarcely exists in any European country a street railway which approaches in its technical and commercial methods those of an ordinary American city. In England the gen-

eral law relating to tramways has imposed such burdens that no company has felt justified in making proper extensions, and we find the development of street railways in London and in the larger provincial cities is behind that of cities in the United States with populations far smaller than those of these great towns.

As I have stated, there are no engineering difficulties in the way of the adoption of electric traction in England. It is true that in America streets appear to have been made for tramways, while in England the topography of the town taxes the ingenuity of engineers; but, on the whole, facts and figures show that in many respects, Europe is if anything even a more favourable field for electric traction than America.*

What then, are the obstacles? The answer is not a simple one, and requires at least a brief statement of some political and sociological tendencies which have existed in Great Britain during the last decade or two.

All economic problems are highly complex, and the mechanism which sets social forces in motion is not always visible; but there is

* For a long time we were told that English people would not tolerate overhead wires and that, until some more attractive looking system was developed, electric traction would not be adopted. But this is not correct. The mass of the people knew nothing about it. These matters are decided by the town councillors and they never considered the question. As soon as they were forced to consider it and to examine the overhead system they decided in favor of it.

A committee of the Glasgow Corporation reported in July, 1896:

"With regard to its appearance and operation as we saw the system on a large scale in Hamburg, we found that the real objections to it are very much less on the spot than we had anticipated."

A committee of the Belfast Corporation reported in March, 1896:

"All practical objections to the overhead system have been surmounted, and any exception thereto from an æsthetical point of view has been reduced to an almost infinitesimal quantity in the best examples of the overhead system."

The general manager and the engineer of the Glasgow Corporation tramway reported in November, 1896:

'We are perfectly reconciled to it, and feel that it only wants to be seen to be appreciated."

The committee of the Sheffield Corporation reports:

"The chief objection urged against the overhead system is its appearance, but the deputation, from their own personal observation, have come to the conclusion that very little objection can be taken from an æsthetic point of view"

The committee of the Hull Corporation reports in April, 1897:

"The objection[to overhead wires] appears to be largely due to prejudice, and is to a great extent removed by familiarity with the overhead equipment, and to a still greater extent removed by a recognition of the superior facilities afforded by electric traction."

The committee of the Liverpool Corporation reports in July, 1897:

"With regard to the objections that have been raised to the overhead system on account of . . . unsightliness of overhead construction . . . the deputation would point out . . . that with properly designed supports, and with wiring carried out with due regard to appearance, the unsightliness is so far minimised as practically to disappear."

The alleged objection to overhead wires is not therefore the reason for the delay in the adoption of the system in Great Britain.

observable a swing of the pendulum of public opinion in these matters as well as in politics and other departments of life. The great development of industries by means of private enterprise in the early part of the present century has produced a reaction which, during the last twenty or thirty years, has had the effect of discouraging the creation of undertakings partaking of the nature of monopolies. At one time practically all new undertakings of this character were established by corporate or governing bodies, and private individuals were, to all intents and purposes, prohibited from participating. Then, for a time, the expression of public opinion and the policy of Parliament were in favour of encouraging private enterprise. Political economists pointed out the superior energy of individual enterprise; the laws of partnership were altered to enable the capital of many individuals to be united for a single purpose, and a great stimulus was given to industries of every kind by the progress of engineering science and the accumulation of capital seeking investments. Canals, docks, light-houses, turnpike-roads, bridges and ferries, railways, and gas and water undertakings were all carried out by reason and in consequence of the protection and encouragement offered to private capitalists; and it must be admitted by even the most ardent collectivist that by this means, the country has been supplied with necessaries and conveniences which the State or municipalities would never have provided. But, on the other hand, it must also be admitted that the monopolies which were granted were not sufficiently restricted in the interests of the public. This led to an outcry against the further creation of big monopolies, and the Board of Trade and also Parliament recognized that there were many points in which the interests of these companies were at variance with those of the public. The conditions, however, which were imposed for the purpose of preventing these monopolies from being injurious to the public were very tentative, and a former permanent secretary of the Board of Trade has stated that these remedies have often proved inadequate and sometimes mischievous, and that, whilst it is right and necessary to impose some restrictions, yet, without great caution and wisdom such restrictions are likely to be injurious to the public as well as to the companies.

One of these tentative and mischievous measures, prejudicial alike to the public and investors, was the Tramways Act of 1870. That was the first general act of Parliament in this century which in its effect discouraged private enterprise in Great Britain. Twelve years later it was followed by the Electric Lighting Act; but by that time.

capitalists had become shy. They had seen the effect of the Tramways Act and they would have no more of the principle which it expressed. They did not make the mistake of tramway investors who had put about twelve millions of capital into the tramway industry and had thus given British legislators at that time the impression that the principle embodied in the Tramway Act was acceptable to capitalists. Although many millions of capital were subscribed in 1881 and 1882 for electric lighting, prior to the passing of the Electric Lighting Act, not one of the sixty-two provisional orders granted to companies in 1883 was carried out. Capitalists declined to go on with a business which, if successful, could be taken away from them by local authorities at the end of twenty-one years upon terms of paying the then value without regard to past or future profits, goodwill, or other like considerations. But it nevertheless took Parliament six years to recognize the mistake which had been made by the passing of the Electric Lighting Act of 1882. It was not until 1888 that an act was passed amending the period of purchase from twenty-one to forty-two years. Then, for the first time, electric lighting went ahead in Britain, although other countries had long previously enjoyed its benefits.

But the poor tramway companies have never had their oppressive act of Parliament altered. These undertakings are now being bought up by local authorities after a twenty-one years' pitiful existence, at the price of the old rails and plant. With the exception of a few undertakings in large cities or otherwise favourably situated, all tramway companies in Great Britain have proved lamentable failures. And why? Because the companies, knowing that they would be bought up at the end of a few years, have been unable to expend any capital on improvements, and have been debarred from doing what, in the words of Bacon, is so essential to the development of all commercial enterprise:

> "A man may not look to sow and reap at once,
> But must prepare business, and so ripen it by degrees."

The limited tenure allowed by the Tramways Act is not, however, the only reason which accounts for the non-success of tramway companies in Great Britain. We are frequently told that tramway companies have been over capitalized; and as a matter of fact the capital expenditure per mile of English tramways is very much in excess of the capital expended on street railways in America, notwithstanding the improved method of traction there experimented upon and adopted.

We are told that English tramway companies could not be expected to make satisfactory returns upon their inflated capitals. Of course not; but what is the reason for their exceptionally large capital expenditure? I have no wish to defend unscrupulous promoters of companies and I am ready to admit that sometimes companies are formed on the basis of the promoters and vendors taking the whole of their profits at the formation, instead of making them dependent upon the success of the companies; but a careful and impartial inquiry into the history of tramway undertakings discloses the fact that, where there has been over-capitalization, it is mainly the result of the conditions imposed upon promoters by Parliament, the Board of Trade and the local authorities. It is not necessary for proof of this statement to show that every shilling of excessive capital has been expended upon works. If an undertaking is surrounded by undue risks, obligations, and difficulties, it will cost more to establish and to complete it. Greater efforts and sacrifices have to be made to get the undertaking financed and carried out. All kinds of expensive precautions against financial disaster have to be taken and paid for so that, without increasing the profits of promoters, more money is taken out of the undertaking for promotion expenses than would be the case if the undertaking were permitted to be a normally safe investment.

One of the most fruitful sources of trouble has been the fact that, under the Tramways Act, the assent of the local authorities has to be obtained, as a condition precedent, by the promoter of a tramway. This condition should not *per se* be a hardship upon the promoters; but, unfortunately for the development of the industry, the local authorities have made it so. The veto which they possess under the Tramways Act enables them to impose onerous conditions, not to be resisted by promoters, some of whom would rather accept impossible conditions and obtain a concession which they hope to sell than face the loss of the expenses they have incurred.

These impossible conditions take a variety of forms; but, unless the scheme is abandoned, they are expressed by inflated capital or reduced profits, or both, and they manifest themselves to the general public by the inability of the company to give satisfaction.

The whole tendency of late has been to regard commercial promoters of public works not as benefactors, or as people rendering a public service and therefore entitled to a fair reward for their labours and risks, but rather as people who have no interests in common with the public they serve. In theory and in law, the right of a tramway company to use the street is granted on the sole ground that it is for

the interest of the public that they be allowed to do so. The grant of the powers is an accommodation to the public and not a privilege or gift to the company, and, therefore, the company should be fairly remunerated for rendering a public service; and the better the company does the service, the better it should be rewarded; but local authorities now generally take the view that the promoter of public works is an usurper who should be mulcted and discouraged rather than assisted.

This view is not held by reponsible legislators nor by representative institutions, but is forced upon them by the organizations and influence which municipal corporations are able to bring to bear.

When the Electric Lighting (Amendment) Act of 1888 was under discussion, the Society of Arts presented a petition to Parliament which stated that "those willing to provide the electric light are hindered by the existing state of the law, and that in consequence the development of electric lighting in England has not been equal to its development in other countries, where no such artificial hindrances existed. The Institution of Civil Engineers and other bodies supported this view by resolutions and petitions. The prime minister, on the discussion of the bill, said that he inclined "to go back to ideas of less restriction and greater freedom in this matter, and to allow enterprise to have its full swing, to remove the obstacles which had hitherto impeded it, and offer terms, not such as they thought the capitalist ought to accept, but which they found by experience he would accept. So it might be possible, by giving rights which were generous and large, to procure for the public the full advantage of those scientific inventions which other nations had and which now, by our restrictive policy, we prevented the public from enjoying without doing any good to the local authorities, which were the subject of so much tender care."

Again, in the last session of Parliament a select committee of both houses, after hearing a mass of evidence tendered by the Board of Trade, by local authorities, and by electrical companies, reported as follows:

"The Committee think the provisions of the Electric Lighting Act, 1888, enabling the local authority to purchase an undertaking after a term of years, inapplicable, as a general rule, to the case of an undertaker supplying energy in bulk at high voltage, but there may be special cases where it is desirable that the local authorities should have the right to purchase reserved to them. To meet such cases they suggest that the Board of Trade should have power to insert the purchase clause in the Provisional Order, if the local authorities concerned can, in the opinion of the Board, show good cause for such a course.

"The Committee consider that the provisions of the Electric Lighting Act, 1888, which require the consent of the local authority as a condition precedent to the granting of a Provisional Order, should be amended. In their opinion, the local authority should be entitled to be heard before the Board of Trade, but should not have, so to speak, a provisional veto, only to be dispensed with in special cases by the Board of Trade."

The adoption of electric traction by existing tramway companies involves, as I have stated, an enormous expenditure of capital. The old rails have to be replaced by heavier construction; new electric-motor cars, costing about £700 each, have to be provided in place of the old; electrical equipment is required in lieu of horses, and these have to be sold at a loss; the stables are no longer needed, and expensive power houses with delicate machinery have to be erected in their place. It is not an exaggeration to say that electric traction cannot be adopted on many of the existing lines without at least doubling the capital. Is it likely that any body of shareholders would agree to this expenditure with the risk of being bought out after the lapse of the few remaining years of the period of pre-emption mentioned in the act?

The foregoing are, briefly stated, the chief reasons why electric traction has not been adopted in Great Britain in substitution for existing forms of tramway locomotion; and also why, until the passing of the Light Railways Act, scarcely any new tramway lines were promoted under the Tramways Act even with the promise of the improved results to be obtained from working by electricity.

It is generally recognized that the local authorities are the custodians of the highways, and that it is their duty to protect the interests of the ratepayers; but the point which they ignore is that the people who provide a satisfactory service of electric tramways, or light railways, are rendering a public service which all who have witnessed the results of the introduction of electric traction in other countries admit are of enormous benefit to the towns and districts served by this form of locomotion.

There is no reason why England should not likewise secure these benefits if only her municipal authorities would approach this question in a fairer spirit and recognize the fact that so complex a business as that of electric traction requires a very large technical experience, is attended by considerable risks, and that the undertakers are entitled to a reasonable return for their services and for the capital invested.

Abundant evidence is available that this spirit is not generally adopted by local authorities in dealing with tramway undertakings; and the three following concrete cases will serve as illustrations.

(a) A tramway company sanctioned by Act of Parliament obtained statutory power to adopt electric traction. For the purpose of carrying this out, the angles of the loops or passing places on single lines had to be slightly eased so as to enable the electric car, which cannot—like the horse car—be pulled to one side, to pass over them. The corporation objected to these alterations being made, unless the company agreed to widen streets in other parts of the town. The result was that the introduction of electric traction was delayed until this legal point was settled, and the company has nothing to show for the unnecessary law costs it had to incur.

(b) Upon the invitation of a corporation, a tramway was promoted. The corporation insisted upon the scheme being enlarged by lines being added which were not needed, except, perhaps, to increase the value of some building plots, and which lines, in the opinion of the company, would not pay to work for very many years. Many other serious conditions were imposed, and as the company declined to accede to these conditions the corporation opposed the confirmation of the order at every stage of its progress; as there was no longer any prospect of the undertaking becoming remunerative, the order was withdrawn, and there is no electric traction in that town.

(c) In the case of a tramway worked by steam without any profit, application was made for the necessary powers to work the line by electricity. The corporation approved of the proposal, but made it a condition of their assent that the electrical energy should be purchased from an electric-light station which the corporation proposed to establish. The electric-light station by itself would probably not pay, as the town is a very small one; but the corporation hoped that, by obtaining the tramway as a customer, they would be able to make their proposed electricity-supply works remunerative; but so doubtful was this that they would not undertake to supply the electrical energy except at a price which would be higher than the cost of working the tramway by steam power.

These cases are typical, and they show the kind of difficulties which municipalities put in the way of undertakings, even in those cases where the desirability of providing electric tramways is admitted; but there are a large number of cases where, owing to the difficulty of getting any decision from local authorities, even this stage has not been attained, notwithstanding months and even years of weary negotiations.

One of the principal reasons urged by local authorities for their

harsh treatment of tramway promoters is that tramway companies in the past have been a failure commercially, that they have left the track in a bad condition, and generally, that they have failed to carry out their obligations. But this is the very result to be expected from the policy of imposing burdens which prove too heavy to bear.

It would have been better for the industry if, in the early days of the Tramways Act, promoters had been strong and honest enough to reject a tramway order which had been commercially spoilt by the heavy burdens imposed by local authorities as the price of their assent; for such undertakings are but an eye-sore and a source of trouble to everyone ever afterwards.

It will probably be answered by those who support the present movement in favour of the municipilization of industries that it does not matter if private enterprise is discouraged; that municipal corporations will take up the work which private capitalists refuse to undertake. I cannot attempt to state all the pros and cons of this question, but I will mention one fact that is not contentious, and which, I think, will show that this view is not compatible with the best and fullest development of this industry; that is, that if municipalities carry out tramways within their own areas, out-lying villages and towns too small to adopt the principle of municipalism are bound to be neglected and both the large towns and the sparsely-populated districts will suffer in consequence. If this, in turn, is answered by the argument that municipalities should be allowed by Parliament to work tramways outside their areas, then I say (without going into the question, among many others, whether people in one district should be rated for the purpose of rendering service to people in other districts) that it has already proved impracticable, notwithstanding the ambitious proposals put forward this session by Manchester, Glasgow, and other municipalities. The jealousies and want of unanimity between adjoining local authorities are such that a company whose tramway, only seven or eight miles long, passes through the areas of three local authorities, was requested by each authority to adopt an entirely different type of car, and it was only by reference to arbitration that this difference could be settled. Both Bradford and Leeds, only eight miles apart, have municipalized tramways, but they have not been able to agree upon a gauge common to both, and inter-communication by tramway is impossible. An industry which for its proper development must extend in every direction required by traffic is not suitable for the enterprise of municipalities whose operations should be confined to their own areas.

Several bills have been introduced in the present session of Parliament which will clearly raise the issue of municipalization of industries versus private enterprise; and the pioneers of electrical traction in the United Kingdom are awaiting the result with much interest; for promoters who have a sense of responsibility towards their shareholders are anxious to know whether they are needed for the development of this industry or not. If they are told they need not apply, then they will be free to employ their energies and capital in other branches of industry, in other countries if not in England. If, on the other hand, private enterprise in this industry is to be encouraged, then promoters of electric tramways should not be discouraged by being required to accept a smaller reward for their labours and risks than is afforded to other industries.

With the experience which the closing century has given, to legislators and government departments, of unrestricted monopolies on the one hand and throttled enterprise on the other hand, as well as of an intermediate industrial condition, as exemplified by the sliding scale of profits and auction clauses of the Gas Acts, it should not be very difficult to arrive at a fair and equitable adjustment between the interests of the public and the rights of the capitalist.

This problem will probably require a different solution for different industries; but in the case of tramways and light railways the right solution will, I think, be based upon the principle of municipalities owning the track, so as to give them the control of the streets, and the working of the line being entrusted to substantial parties who have the necessary experience for so complex a business. Some arrangement is no doubt desirable for the division of profits between the two parties, either on the analogy of the Gas Acts or some other fair basis which will secure to the municipality interest on the capital expended and provision for sinking fund, while offering to the operating company a reasonable reward for its service; but the lease to the operating company should be indeterminable so long as the company performs its part of the bargain and continues to give satisfaction to the public. It is only under these conditions that the public can expect the best possible accommodations and all the latest improvements and that the company is afforded a reasonable security of receiving the future rewards which are the outcome of present sacrifices.

THE NEW TERMINAL OF THE ORLEANS RAILWAY AT THE QUAI D'ORSAY.

By Jacques Boyer.

NEXT year France will invite the civilized nations of the world to come and admire the useful accomplishments of human activity. Discoveries of science, master-pieces of art, advances in commerce and industry,—in a word, all that contributes to increase the material well-being of man or his intellectual satisfaction will be represented there. To prepare properly for this triumph of peace many public works, the completion of which had been relegated to a more or less distant future, have been hastened, and their engineers have been put to the necessity of transforming Paris into an immense workshop.

From the beginning it was decided to permit the railways to come into the centre of the city. This is the first step toward the central railway terminus, so long needed, which will permit through travel from Calais to Marseilles, for example, without necessitating a stop at Paris. This through passage is at present impossible. Once arrived at the Gare du Nord (see Fig. 1), a passenger must claim his luggage, have it transported by vehicle to the Gare de Lyon, and, to continue his journey, again go through the formalities of taking a ticket, registering his luggage, etc. It was to avoid these losses of time and these useless expenses that the companies concerned elaborated the plans now in course of execution. While these will not, at their completion, sensibly modify the existing state of things, they tend to that end; but the companies proceed timidly and in a desultory fashion, instead of squarely attacking the problem. Plans for united action thus fail, and the result finally obtained will be unsatisfactory.

The Orléans railway is prolonging its tracks from the Place Valhubert to the Quai d'Orsay. The Compagnie de l'Ouest is moving its terminal station from the Champ de Mars to the Esplanade des Invalides, and this part of its system will be closely connected with the Ceinture railway at the Courcelles station. Meanwhile the Metropolitain underground railway is under construction—better late than never.

Railway lines, however, are not the most important works now

under way in the "City of Light." There remain, as subjects for following papers, the Alexander III. bridge, that remarkable work of MM. Resal and Alby, and the construction works of the exposition, which will be taken up in detail, describing the beginnings of work upon the palaces of the Champs-Elysees and the Champ-de-Mars. The present paper will discuss only the prolongation of the Orléans railway.

During the last dozen years the ever-increasing traffic of the French railways has compelled the companies to enlarge their Paris

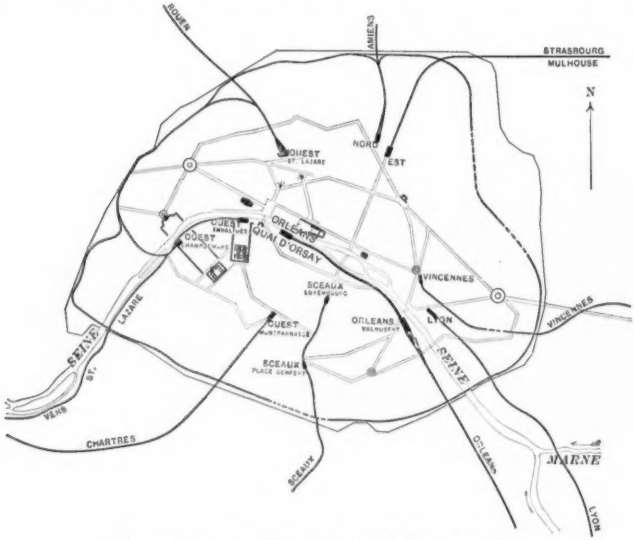


FIG. 1. MAP SHOWING RAILWAY TERMINI IN PARIS.

termini. The Western and Northern systems were the first to set the example, while to-day the Eastern and Lyons systems are remodeling their old stations, which the development of business has overcrowded. These last two have rebuilt on their old sites, or, to speak more accurately, have erected new buildings in the immediate vicinity of the old ones. On this account these possess no great interest. For the Orléans company, however, the question was very complex. Its system, some 7,000 kilometres in length, covers a vast extent of the south and south-west of France, and the station at the Place Valhubert (see Fig. 1), where it terminated, was too far from the centre of Paris,—the city growing constantly towards the west, the precisely

opposite direction. Extension in this direction is not peculiar to the capital of France, for, curiously enough, it is also going on in the greater number of the large European cities.

The general movement tends, thus, to leave further and further behind the stations situated in the eastern part of Paris. Since Paris as yet has no metropolitan railway to facilitate access to the various stations from the central part, this inconvenience must be somehow remedied, especially as the present defective means of transportation is badly adapted to surburban service. Since the principal efforts of the Orléans company have been directed latterly to the betterment of

FIG. 2. RUINS OF THE COUR DES COMPTES, TO BE REPLACED BY THE NEW TERMINAL.

its surburban service, it was more than ever urgent for it to approach the centre of the city as closely as possible.

To give an idea of the improvement in its schedules it may be mentioned that, to-day, people living within a radius of 250 kilometres can pass the business day in Paris. Leaving home at about 8 o'clock in the morning, they reach Paris at noon. To be at home by 10 o'clock in the evening they return at 7 o'clock, thus having about seven hours in Paris for their business, as they can have luncheon and dinner in restaurant cars. Thirty-five years ago these future needs were unthought of, for in 1862 the Orléans company simply rebuilt its old station buildings, which had become too small, on the same site—at the Quay d'Austerlitz.

Later, in 1892, the management found itself confronted with a similar situation for its narrow-gauge system, which comprises two surburban lines,—Paris to Sceaux, 12 kilometres, and to Limours, 41 kilometres. This station, far from the centre of the city, at the Place Denfert (see Fig. 1), had to be abandoned for another at a more convenient point; so the company extended the lines to a terminus at the Luxembourg. Work on this extension of one and one-half kilometres was finished in 1895, and resulted in an increase of earnings of 40 per cent.

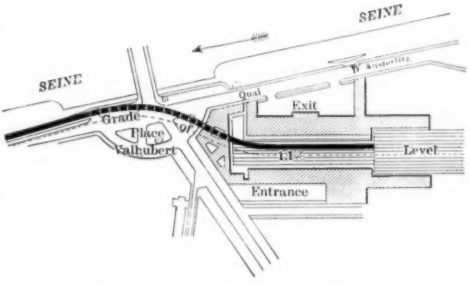


FIG. 3. PLAN OF THE OLD ORLÉANS STATION.

Experience having thus fully justified the expectations of the engineers, and spurred them to a similar undertaking on a bigger scale, the terminus of the line will soon be transferred four kilometres further west, to the situation formerly occupied by the ruins of the Cour des Comptes (Fig. 2). This building, which was burned during the Commune of 1871, has remained unoccupied since. It was also, like the d'Orsay barracks, situated alongside of it, in a very bad condition. The demolition of these buildings gave rise to no great obstacles, and the large superficial area thus cleared gave excellent opportunities for the erection of the new building. The junction of the old with the new stations presented no insurmountable difficulties, the quais on the bank of the Seine being evidently the proper situation for the line.

The company entered into negotiations with the government, to which these properties belonged, and finally received a grant, voted by the chamber of deputies and ratified by the senate, on November 29, 1897. Soon afterward, in April, 1898, ground was broken. The pulling down of the buildings was carired on rapidly, and to-day the works of reconstruction are going on night and day at various points of the line. They are directed by MM. Brière and de la Brosse,* engineers of the Orléans Company.

To better set forth the interesting particulars that are encountered

* The author desires to thank M. de la Brosse for the permission kindly granted him to visit in detail all the yards and works, and to take notes at his leisure from the different contractors.

in going over these works, let it be supposed that one follows the bank of the Seine from the Quai d'Austerlitz up to the Quai d'Orsay, and thus enters immediately into the heart of the work.

The present station, at the Place Valhubert, is a hall 50 metres wide and 300 metres long, covering seven dead-end tracks, which are approached by four platforms. Of these tracks only the two central ones are prolonged to form the new extension. These, before turning toward the Seine, pass under the building containing the administrative offices, which, for various reasons, could not be removed without great expense. The grade from the Place Valhubert is very considerable—1.1 per cent. for 44 metres. Leaving the old station, the new line goes first to the Quai St. Bernard. Along this part the banks of the stream are occupied by a highway and a levee, or sloping bank, for unloading boats. The latter being very wide, it was possible to take 9 metres of it without inconvenience to vehicular traffic, and in this way an uncovered line was built upon the levee, up to the Sully bridge. The length of this section is 650 metres. From this point the road will be underground, up to the d'Orsay station, passing under the high part of the quai, where the vehicle traffic will continue as before. For ventilation windows will be cut on the river side, though these will not be sufficient for the lighting of the tunnel, which will be effected by electric lamps, distributed at regular intervals.

The works just below the Sully bridge are carried on in several sheds. As shown in the illustration (Fig. 4), the shed on the extreme left contains the cement-mixing machines; others house the dynamos, a forge shop, drainage pumps, and workshops for repairing tools. The little locomotive shown is used for hauling material for the construction of the tunnel, the entrance of which is just beyond the right of the picture, and also for removing the excavated materials to the river. The materials for construction are brought on boats, so as to cause the least inconvenience to traffic and the public. The cars drawn by the small two-ton locomotive are dumped into flat-

FIG. 4. WORKINGS NEAR THE SULLY BRIDGE, SHOWING A DECAUVILLE LOCOMOTIVE.

ENTRANCE OF THE TUNNEL AT THE PLACE VALHUBERT.
(Photographed from the interior, February 15, 1899.)

boats with sloping sides, which can carry 800 cubic metres at a load. The method of building the tunnel merits mention, for it seems practicable in all similar enterprises where it is necessary to work without making open cuttings. A metal shield sustains the rather thin layer of earth separating the level of the pavement above from the extrados of the tunnel arch during the progress of the work. This apparatus is pushed forward by hydraulic jacks at the rate of 1.1 metres in 40 minutes, and the masonry work follows it up at the same rate. At the time of the author's visit—in December, 1898—260 metres of this tunnel were finished.

On account of the heavy grade at the Place Valhubert, the rest of the profile is nearly level, its maximum grades not exceeding ½ per cent., and the radius of curves being nowhere less than 150 to 200 metres. Since the rails are to be at the mean water-level of the Seine, it was necessary to build inverted arches at the bottom of the tunnel, to resist, in case of freshets, the upward pressures to which the work will be exposed. A central drain receives the infiltrations, and pumps at the lowest point of the line free the tunnel of this water when neces-

sary. That the stability of the various bridges along the route may not be affected, the line has been turned out to avoid their abutments. The general disposition of the works, excepting the uncovered portion along the Quai St. Bernard, falls into four types of cross-section. For the 900 metres between the Sully bridge and the Petit Pont the sur-based arch will have an opening of 9 metres, and will be built of masonry. For the 500 metres following, the layer of earth between the top of the arch and the roadway above being too thin for this construction, the cutting is covered with a metallic roof of 8 metres' opening (see Fig. 6).

In this stretch between the Petit Pont and the Pont St. Michel a station will be built, which, without doubt, will be largely used in the future by suburban passengers, since the line to Sceaux will also come in at that point. As a provision for this, the platform to be constructed there will have a length of 230 metres, to render access to the trains as easy as possible. Fig. 8 shows the foundations of the buildings which have been erected at this point, and also gives a general idea of the type of tunnel with metallic roofing.

From this point the type of all-masonry tunnel is again encountered, but, to save space for the future construction of a second tunnel, 8 metres wide, intended to carry the narrow-gauge Sceaux line from the Luxembourg to the Quai d'Orsay, the width of this tun-

VIEW OF THE OPEN CUTTING ALONG THE QUAI SAINT BERNARD.

nel will only be 8 metres (see Fig. 7). Five hundred metres of this work will be constructed at once, and will serve for shunting tracks pending completion of the rest.

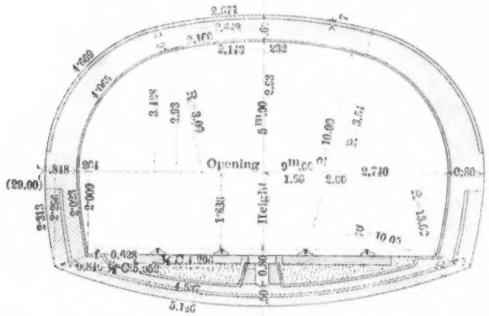


FIG. 5. CROSS SECTION OF TUNNEL BELOW SULLY BRIDGE.

This leads us to the terminal point of the line. Here the work of demolition was also begun in April, 1898. The buildings of the Cour des Comptes (see Fig. 2), solidly built of cut stone and ashlars, presented a very difficult task. The peculiar arrangement of

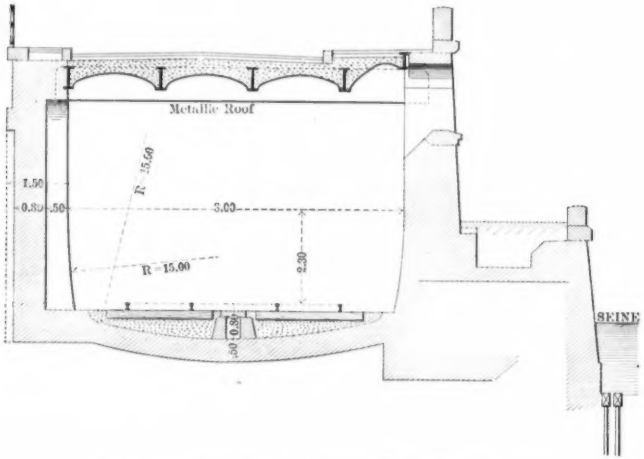


FIG. 6. CROSS SECTION OF TUNNEL WITH METALLIC ROOF.

this burned building, with solid walls and without any floors, increased the difficulties. As far as the d'Orsay barracks were concerned, their thinner walls were easily thrown to the ground. After four months, 30,000 cubic metres of material, among which were 10,000 of fine cut stone, which the contractors will use in the future constructions, were carried away, and on August 4, 1898, the works on the foundations were begun. There being no time to lose, the foundations of the d'Orsay station were finished in January, 1899.

The conditions of work, in view of the limited space (75 by 175 metres), the short time granted contractors for finishing it, and the clause which forbade them to interrupt traffic in the neighboring streets, rendered the task one of peculiar delicacy. It was impossible to begin excavations immediately in the quai for the placing of

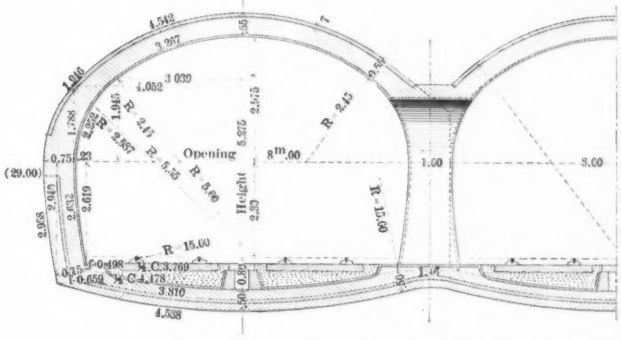


FIG. 7. CROSS SECTION OF DOUBLE TUNNEL BELOW PONT ST. MICHEL.

the metallic apron to be built along the new structures, on account of the main sewer of la Biévre, which occupies the same place. It was necessary to wait until this had been diverted. These considerations require the construction of a subterranean passage, opening at the lower quai level on the Seine, and establishing from there a sort of communication with the interior of the workings. This gallery, through which is handled the material removed during the construction, is formed of two timbered passages, each 2.8 metres high and 3 metres wide, and each provided with tracks for the little cars drawn by a small Decauville locomotive, similar to that shown in the illustration of the Quai St. Bernard. The construction of these tracks required the cutting into the upper part of the main sewer for 1 metre. This necessitated the construction of a metallic apron sus-

tained by iron I-beams resting on the abutments of the arched roof of the sewer, which are vertical at this point. The flow continues normally, since the level of the water never reaches the height of this apron.

These preparations finished, and a fence having been built around

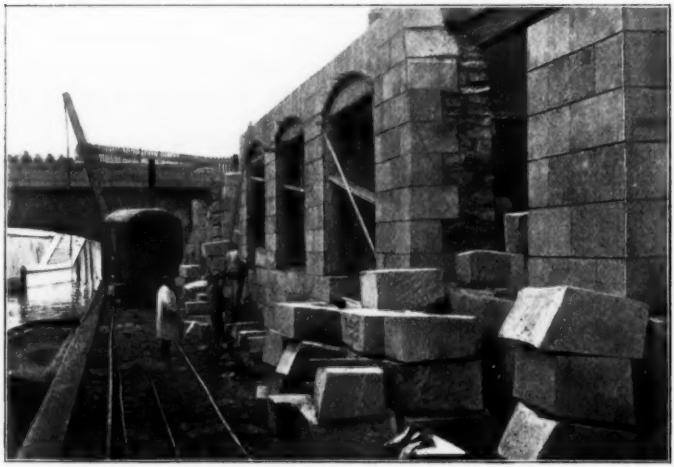


FIG. 8. TYPE OF CONSTRUCTION BETWEEN THE PETIT PONT AND THE PONT ST. MICHEL.

the site to keep out the public, work was begun simultaneously in five places. The plan (Fig. 10) shows the arrangement of these, and the illustration (Fig. 9) gives an idea of the condition of the work in December, 1898. The photograph was taken at the foot of the Rue de Bellechasse. At the first of these places the bucket excavator of the Couvreaux system, shown at work in Fig. 11, was put in operation, its efficiency being superior to that of the steam shovels which seem to be preferred in England and America. Using about 70 h. p., it handles 400 cubic metres of earth in 24 hours, and at the present time is working along the Rue de Lille side of the grounds. The excavated matters are dumped into cars running on track No 1 (see Fig. 10), whence they are finally delivered to barges on the river. Their manipulation is not difficult, since the soil is composed of a first layer of alluvial earth 3 metres thick, below which is clay, beds of peat here and there, and sand at a depth of 5.5 metres below the street-level. The big broken stones seen in Figs. 9 and 11 come from the buildings which have been pulled down, and are to be carried away by the masons.

The triangular block (see Fig. 17) in the angle between the Rue de Lille and the Caisse des Dépôts et Consignations has not yet been disturbed. At present it is used as storage-space for the structural steel, most of which is furnished by Moisant, Laurent, Savay & Cie., of Paris, to be used later in the foundations of the new buildings.

The second workings are near the first. There the walls of the future station are going up on the Rue de Lille front. The width of this street will be increased from 10 metres to 16, and the space thus gained from the present street line will be vaulted over and used by the railway company as storage room. At this place the excavation, 5 metres wide and 7 deep, has gone on rapidly and easily, the foundations of the old barracks, which stood there, being scarcely more than 3.50 metres deep. On the site of the third workings work was by no means so easy, for here massive masonry of great ashlars reaches to a depth of 5.50 metres below the ground-level. In other places along the front of the quai, are encountered enormous masonry foundations, 2 metres wide and 2.50 metres thick, extending through the whole height of the work, and corresponding to the façade of the old buildings of the Cour de Comptes.

The fourth workings are also shown on the plan (Fig. 10). They are finished to the required depth, 5.50 metres below the level of the

FIG. 9. GENERAL VIEW OF WORKINGS AT THE QUAI D'ORSAY.

neighboring streets, and in them have been commenced the excavations for the foundations upon which will rest, through the intermediary of a layer of concrete* 20 centimetres thick, the steel frames of

*This concrete is made of 250 kilogrammes of cement to one cubic metre of gravel and one-half cubic metre of sand.

the ground floor of the future station. As these foundations are 2.50 metres below the level of the Seine, they have been invaded by water. Ditches have been run from them to a central cistern, which is kept clear by six pumps, in continuous operation. Three of these pumps are worked by hand and three by electricity, the current being generated by dynamos driven by a 20-h. p. traction engine in the shed *g* (Fig. 10). At the height of the platforms of the station a course of 4 centimetres of neat cement will be laid in all the masonry work, this impervious layer being intended to cover all the walls of the lower story, so as to prevent any infiltration of water that might, without reference to freshets in the river, produce pressures upon the structure. In this connection the work has been superbly done, the revetment actually surpassing that of the Suresnes dam in thickness by 2 metres.

The fifth workings are on the lower level of the quai. There a new landing is being built, the walls being 3 metres further out than those of the old structure. In this place the work is carried on under conditions very difficult for the men engaged upon it, who are constantly in mud despite the pumps, on account of their nearness to the river. Upon this wall will rest a steel framework, the large bays of which will serve both for the ventilation of the station and the lighting of its interior.

As the work goes on at all the workings, both day and night, numerous incandescent and arc lamps have been installed, as well as a few acetylene burners, furnished with reflectors, and several Wells lights burning heavy oil. These last give most excellent results, and. for equal light, cost much less than the electric lamps. The work

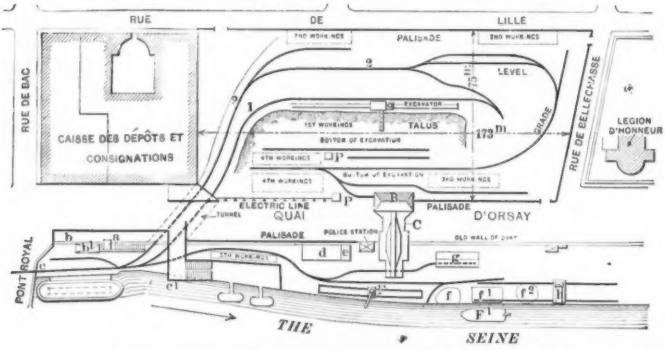


FIG. 10. PLAN OF THE WORKINGS AT THE QUAI D'ORSAY.

FIG 11. COUVREUX EXCAVATOR AT WORK.

done at night approaches in amount that executed in the daytime, but the number of men engaged is very different. The first shift consists of scarcely 100 men, while the second ranges between 300 and 325. It is almost an achievement, and one upon which the engineers in charge should be congratulated, that all this activity, confined to its narrow limits of space, has not in any way interfered with traffic.

It is well to indicate at this point certain of the general arrangements which have been carried out. The excavated materials are removed from the work by means of one hundred and twenty dumping cars, hauled either by horses or Decauville locomotives, one of which is of 2 tons', and the other two are of 5 tons', weight. The plan (Fig. 10) shows very clearly the temporary tracks, of 0.60 metre gauge, which have been laid through the workings. The lines marked No. 1 and No. 2 extend to the provisional gallery, which passes under the quai and empties at *c*, and where the materials are dumped on flat boats. Referring still to the plan, *b* shows the repair-house for these cars, and *a* the office of the contractors, MM. Brissot, Peraglie, and Rigault. The carpenter shop is shown at *b*. Construction materials, cut stone, gravel, sand, etc., arrive by boats on the river. A 6-ton steam crane, *F*, or a floating elevator, F_1, of 5 tons' capacity, discharges them at *f*, f_1, f_2, and the traveling crane, *h*, allows them to be distributed along the lower level landing. The

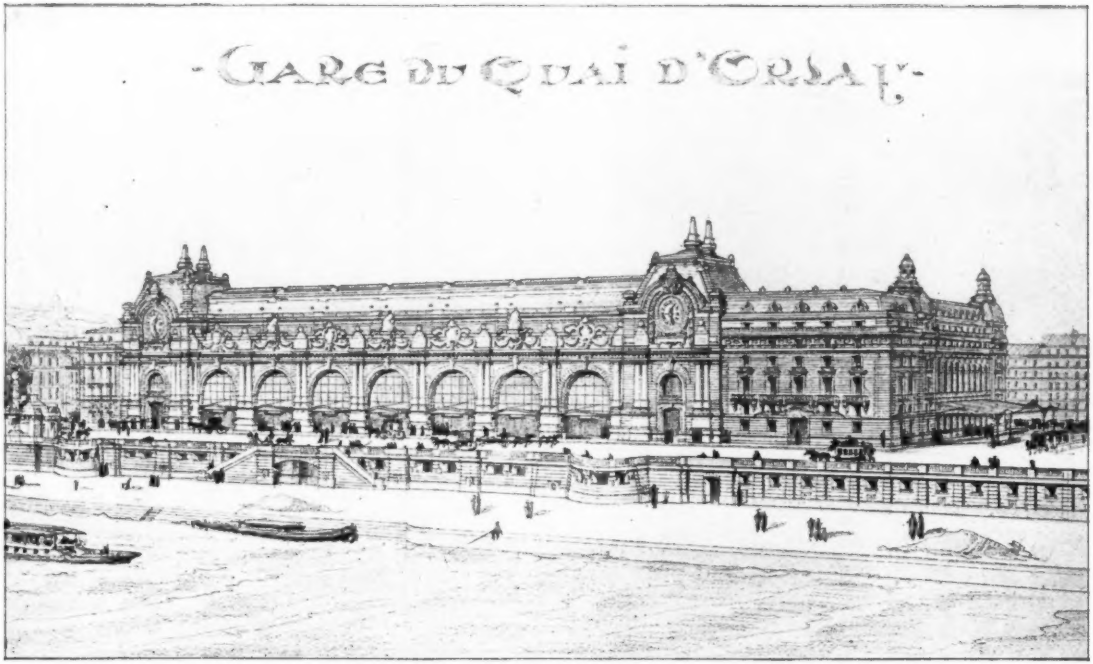


FIG. 12. THE QUAI D'ORSAY STATION, FROM THE ARCHITECT'S DRAWING.

scaffolding, which is 6 metres high above the quai, connects the works separated by the wooden fence. The crane handles the materials, which the dumping cars carry back to the concrete-mixer, *B* (seen also in Fig. 9.) This mixer makes 75 to 100 cubic metres of concrete per day. Portland cement is stored in the shed, *d*, and in the building, *e*, is the tool repairing shop.

This is the present state of the work. Looking now at the future constructions, it may be said that the new d'Orsay station will not be

FIG. 13 THE UNDERGROUND OUTLET FROM THE QUAI D'ORSAY TO THE LANDING.

View beneath the Pont Royal, showing the barges for the removal of earth; the Pont Solférino in the distance.

an industrial edifice alone. Its able architect, M. Laloux, has endeavored, with success, to make the artistic part, which was confided to his hands, harmonize with the remarkable monuments surrounding its situation,—the Louvre, the Pavilion of Flora, one of the most beautiful buildings of the old Imperial Palace, and, a little further away, the Tuileries Garden and the Place de la Concorde, without counting the more modest, but very handsome, building of the Legion of Honor, on the same site. The sketch of his design (Fig. 12) shows that he has most worthily accomplished his desire.

The arrangements for train service, designed by M. Sabouret, engineer of the Orléans company, are equally well conceived. The rails come in at 5 metres below the ground line, and the station therefore comprises two levels. It occupies the site where formerly

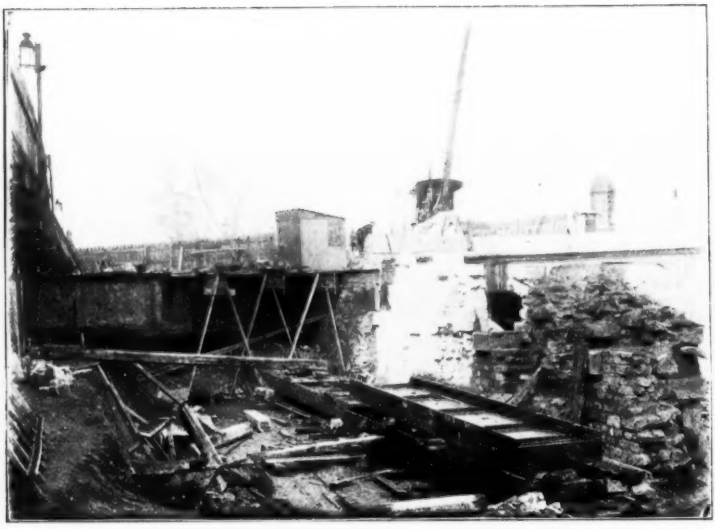


FIG. 14. CONDITION OF WORKS ABOVE THE PONT ROYAL, FEBRUARY 15, 1899.
The railway is to pass under the structure of wrought beams, which contains a water main.

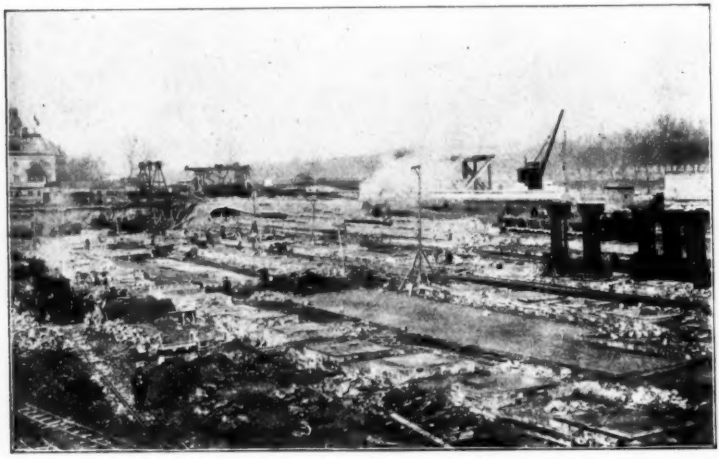


FIG. 15. GENERAL VIEW OF THE WORKS ON THE QUAI D'ORSAY, FEBRUARY 15, 1899.
The main piers of masonry are seen above ground, and the columns to support the metal floor of the station are being placed.

stood the barracks and the Cour des Comptes and the narrow street which separated them. Its form is that of a rectangle about 200 metres in length and 75 metres in width. In the basement (Fig. 17) there are fifteen lines of track accessible to trains, and one on the side of the Rue de Lille,—a single-service track, not in direct communication with the principal lines. The tracks are so situated than any may be used for incoming or outgoing trains. With a view of assuring the regularity of the service, they have been arranged in the following manner. The three tracks nearest the Seine are used for shunting empty cars, and waiting trains. The four tracks nearest these are used for outgoing express trains; upon the next two are handled the surburban service trains, incoming and outgoing. The next two receive the incoming express trains, and, finally, the four

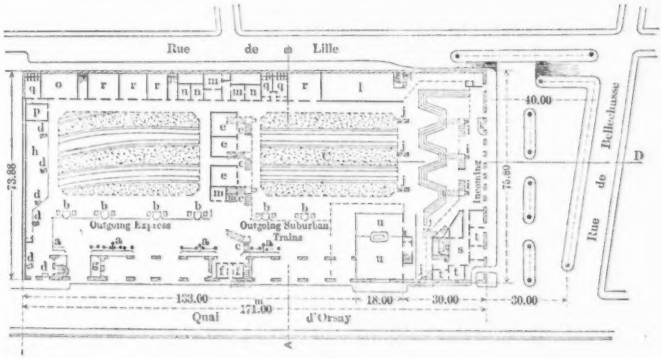


FIG. 16. PLAN OF SECOND FLOOR OF THE NEW QUAI D'ORSAY STATION.

remaining tracks are used, two for suburban trains and two for shunting tracks. Access to the trains will be had by platforms 6 and 7 metres wide and from 185 to 240 metres long. They will be raised to a height of 85 centimetres above the level of the rails, thus permitting the traveler to enter the cars on a level, without ascending or descending steps. Two of the platforms (marked on the plan "for trucks") will be given over to the railway employees, for handling baggage-trucks, lamps, grease-cans, and other necessary service utensils. At the right-hand end of the plan are shown a number of turn-tables, which will permit the turning of the locomotives of incoming trains, the engine being able to go out by one of the free tracks and to be placed at the head of an outgoing train. By reason of the switches on the first five tracks which run into the dead-ends, passing under

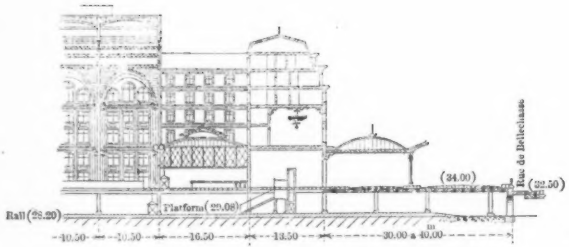


FIG. 18. LONGITUDINAL SECTION OF NEW STATION.

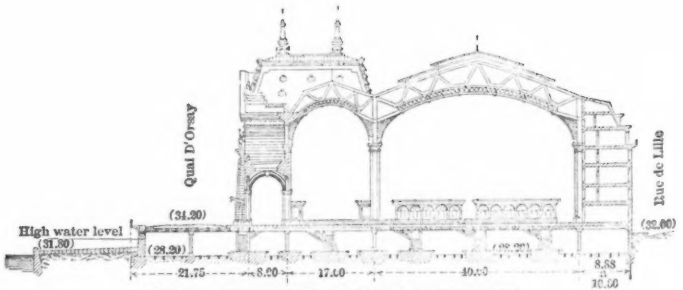


FIG. 19. CROSS SECTION OF THE NEW STATION.

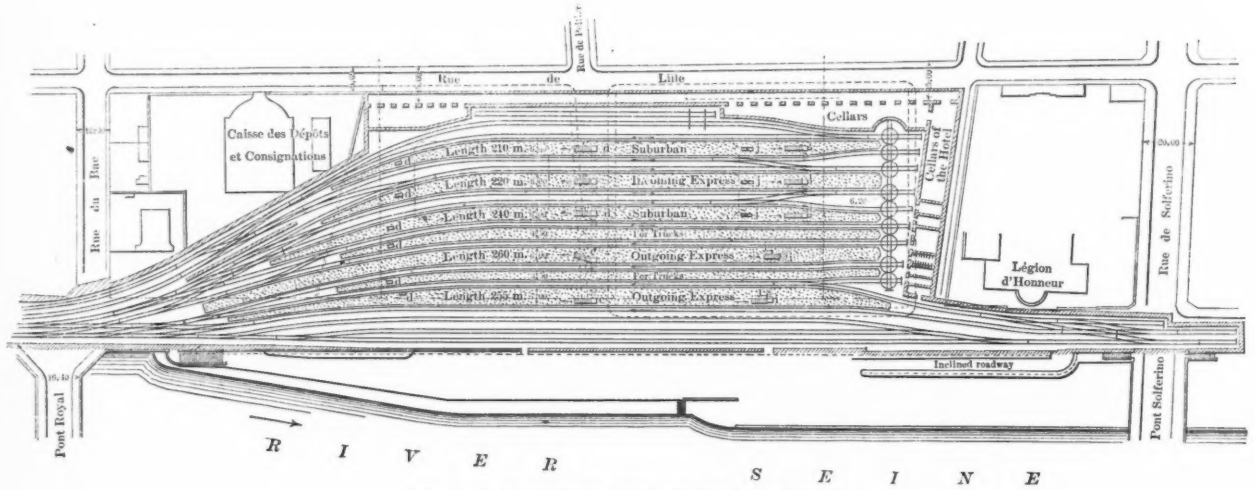


FIG. 17. PLAN OF TRACK LEVEL OF THE NEW STATION.

the Rue de Solferino, a locomotive can be detached from its train when in the station, and sent back without being turned around.

On the second floor (Figs. 16, 18 and 19) the approaches are arranged so that, for express trains, as well as for the suburban service, departing passengers go in on the Quai d'Orsay side, and arriving passengers come out through the narrower Rue de Bellechasse.

Space has been saved by not establishing the customary courtyard for cabs and vehicles. By the provision, all along the buildings, of a gallery 4 metres wide, a vast covered sidewalk has been made, avoiding the standing of cabs, etc., in groups.

At the entrance to the station, in the vestibule, are the ticket offices and luggage-register rooms, shown at *a b*, Fig. 16. The luggage is sent down by the elevators, *d j*, without interfering with the circulation of passengers, who, in their turn, go up and down by the staircases, *c c*, serving each platform.

Incoming passengers are kept separate from those leaving the city. On coming out of train, passengers go out by the bottom of the station, where the staircases and the elevators, *i*, conduct them to a vestibule situated in the interior court on the Rue de Bellechasse side, Finally, since the company's service will utilize only the first story, they have given over the part of the building toward the Rue de Bellechasse for a hotel.

The total of expense required by this prolongation of the Orleans railway line will reach approximately the following figures, taken from the estimate of M. de la Brosse:

Preliminary service and fees of the personnel.....	900,000 f.
Purchase of real estate and indemnities paid to the Caisse des Dépôts et Consignations.....	12,300,000 f.
Works; substructure, diverting water- and gas-pipes, telephone wires, sewers, etc.....	17,550,000 f.
Superstructure; comprising the construction of the St. Michel and d'Orsay stations.....	9,250,000 f.
Total.....	40,000,000 f.

Since the length of the line from the Place Valhubert to the Quai d'Orsay is, in round numbers, 4 kilometres, this amounts to 10,000,000 francs per kilometre—a figure which, without doubt, holds the record. Will the increased traffic compensate the company for its sacrifices? That is a question for the future.

FIG. 17. PLAN OF TRACK LEVEL OF THE NEW STATION.

THE DEPRECIATION OF PLANT, AND ITS RELATION TO GENERAL EXPENSE.

By H. M. Norris.

FORMER articles have dealt with the general bearings of depreciation of plant upon manufacturing costs, and the special application of the principles to drawings, patterns and tools. It remains to treat the concluding items of my classification of the inventory which, it may be recalled, was: A. Standard drawings; B. Standard patterns; C. Standard machinery and tools; D. Special tools, jigs and fixtures; E. Line shafting and accessories; F. Office and shop fixtures; G. Belting; H. Miscellaneous.

"Line Shafting and Accessories," item E, is easily dealt with. It includes nothing but shafting, hangers, and couplings—all pulleys being charged directly to the machine whose countershafts they drive, provision for the recording of which is made on the back of the pages in the Standard Plant Ledger, illustrated in Fig. 1, of the previous article. The cost of erecting a line of shafting is an outlay that cannot be appropriately charged to either Capital or General Expense. It must go to Preliminary Expenses, together with original surveys, plans of buildings, legal expenses, and other kindred items incident to the incorporation of a new company, the writing off of which should be done as rapidly as the profits of the business will allow. In fact, profits are not earned until this debt is cancelled, although it need not necessarily be met, during the first year or two, such a measure often being too severe a burden on the founders, as well as a handicap to the business in general. It can be paid off gradually by applying a certain part of the surplus earnings each year,—say, everything over six per cent,—until extinguished.

With the exception of journals,—the renewal of which goes, of course, to general expense,—a properly-erected line of shafting deteriorates much more slowly than any other kind of plant. Leaving out the question of second-handedness, its depreciation may be said to be practically nil. Hence the rate at which this item may be written off is very low. Some firms combine it with their building account, and depreciate both at the same rate. A rate of 3 per cent. will usually be found sufficient. This will bring a value of $1,000 down to $466.97 in twenty-five years, and to $218.06 in fifty years, which is as far ahead as most of us need look.

"Office and Shop Fixtures," item F, possesses little value as second-hand plant, and should, in consequence, be depreciated liberally. In this classification is included all office and drawing-room furniture, tool-room cabinets, stock-bins, tool closets, men's lockers,—the fittings, in fact, for the entire works. It may be contended that some of these items deteriorate much more rapidly than others, and that, for this reason, the classification is not consistent with good practice. So they do. An office desk, will, for instance, last many times as long as the ordinary work-bench; but, when it is considered that the latter must always be kept in good repair (another general expense charge) in order to produce creditable work, as well as to maintain the appearance of the shop, and to avoid the demoralizing influence which a dilapidated bench has upon the men, the category will not appear so broad. But in some very large shops, where an annual revaluation, or comparison of old figures, cannot be made without considerable labor, it may be expedient to separate the various articles into a number of sub-divisions, grouping each according to its respective rate of depreciation. One must be careful, however, to guard against the danger of over-classification.

Mr. Lewis carries seventy distinct accounts in his General Monthly Journal, among which are such items as "Postage and Telegrams," "Cleaning Offices," and "Staff Refreshment Allowance." Divisions so minute may be very necessary under some circumstances, but are not required in the average shop, employing from one to two hundred men. It may be very gratifying to one's idea of propriety in regard to detail to know just what every kind of outlay amounts to in the course of a year, but the information is not necessary for inventory purposes. The articles are not valued with the object of fixing a selling price, but in order to learn by what amount the assets of the preceding year must be raised or lowered.

"Belting," item G, is often classed in the same category with rapid-wearing plant, such as small loose tools, portable forges, wheelbarrows, etc., but, if any considerable degree of accuracy is sought, it is better to treat it individually, not as a whole, but by separating the belts into three general groups, i. e., G. 1, Cone Belts; G. 2, Shifting Belts; G. 3, Non-Shifting Belts.

I have seen belts of the first group give out in less than three weeks, while others last twenty-five years. The D. I. & E. Greenwald Company, of Cincinnati, is using a 6-inch cross-belt of this class on one of its boring mills, which has driven the machine for thirty years. This, however, is a very exceptional case. Economy demands

that a belt shall be consigned to the scrap-heap in its early stages of decay. This does not mean in ten years, or even in twenty years, but so soon as it shows any material lessening in usefulness, be it in one year, or fifty years.

Belts of the second class are variously estimated as possessing from two to five times the length of life of cone belts, while those of the third group last longer than either of the others. I recently examined a 4-inch heavy single oak-tanned belt which, after fifteen years of continuous service, did not appear more than half worn out. It was a horizontal "shifting" belt, used to drive the countershaft for a 26-inch lathe, and, except for a slight amount of surface cracking, seemed perfectly good. I also saw an 18-inch double "non-shifting" belt which, after forty years of almost continuous running, looked in fit condition to fulfil its duties ten years longer.

Problems of depreciation of belting are confined, in one sense, within a narrower field of uncertainty than those pertaining to the depreciation of machinery, and are consequently somewhat less difficult to deal with. There is, of course, a greater element of danger of loss from accident with belts than with some other plant, but, outside of this one risk, the question is a simple one, as nothing but life need be considered.

Mr. Fred W. Taylor says, in his Notes on Belting,* that the life of a belt depends upon:

(1) The material from which the belts are made, and the method of their construction;

(2) The means of fastening and tightening them on the pulleys, i. e., whether laced, spliced, or fastened with hooks;

(3) The care and regularity with which they are greased, and whether they are kept clean and free from machinery oil;

(4) The general nature of the service which the belts are called upon to perform;

(5) Whether the belts run vertically or horizontally;

(6) The relative length of the belts;

(7) The relative speed;

(8) The tension under which they are run; and

(9) The average total load to which they are subject in working.

Mr. Taylor's experiments covered a period of nine years, and were conducted with sufficient care to enable him to form some very reliable conclusions, the most pertinent of which is:

* Presented at the New York meeting, (December, 1893) of the American Society of Mechanical Engineers, and forming part of Vol. XV., of the *Transactions*.

Double leather belts, when treated with great care, and run night and day at moderate speed, should last for seven years, when under average total load of 111 pounds per inch width, or 385 pounds per square inch. They should last for eighteen years when under average total load of 54 pounds per inch width, 174 pounds per square inch section.

In his summary of results, he gives the percentage of belts still in use after nine years of continuous service as 100 per cent. Between forty and fifty belts were used in the experiment, of which number not one was worn out, the shifting belts looking nearly as good as new. To use his own words:

I think it would be safe to say that the life of the shifting belts will be three times that of the cone belts. The cone belts have reached a point at which it is doubtful whether it pays to repair them, while the shifting belts are, to all appearances, in almost as good condition as when they first went into use, and should last twice as long as they have already.

Continuing, he says:

It is interesting to note that, after 8.8 years of life, the total cost of maintenance and repairs of the shifting belts amounts to only 30 4 per cent. of the original cost, while with the cone belts the maintenance and repairs through a life of 6.7 years amounts to one and one-half times the first cost.

If it is true that a double belt will last seven years when run day and night under an average total load of 111 pounds per inch of width, and eighteen years when under average total load of 54 pounds per inch of width, it ought to last twelve and one-half years when run day and night under average total load of 82½ pounds,—the mean of the two figures used by Mr. Taylor,—which, in my judgment, more nearly represents the average load in the average shop. Twelve and a half years, however, can be taken only as the average life of all belts, while it has been shown that shifting belts will last about three times as long as cone belts. Hence their respective lives are represented by two numbers, the larger of which is three times the smaller and the mean of which is 12½,—that is, by 18¾ and 6¼ respectively. Twenty-four hours per day is equivalent to 168 hours per week. If the belts are run only 60 hours a week, instead of 168, their life will be lengthened in the proportion of 168 to 60, which will give 52½ years in the one case and 17½ years in the other. These figures seem very high, and, if accepted at all as a basis of calculation, should, in prudence, be reduced by a factor of safety of, say, 100 per cent., bringing them down to twenty-five years and eight years respectively.

Since worn-out belting has no scrap value, its original cost must be extinguished within a certain period. This means that it must be depreciated by some other system than by writing off a percentage annually from its diminishing value, which, though showing a con-

stantly-decreasing worth, would never entirely eliminate the belts from the books of the company. If cone belts be assigned a life of eight years, and shifting belts a life of twenty-five years, the cone belts should be depreciated by one-eighth their value the first year, and to three-quarters their cost the next, and the shifting belts by one-twenty-fifth the first year, and to twenty-three twenty-fifths their cost the next, etc. This record may be very easily and satisfactorily kept in conjunction with the plant inventory book, in which each set of belts is distinguished by the number of the machine which the belts drive; any error in writing off will thus force itself on the attention of the manager, or whoever is responsible for the accuracy of the balance sheet.

"Miscellaneous," item H, is the next and last category on our list. It covers all such plant as cannot be appropriately charged elsewhere, as, for instance, land and buildings, which although not intended to be included in this discussion, should receive a word in passing. Land occupied by a manufactory is not apt to depreciate in value, the tendency being rather toward an increase, which frequently runs far beyond its original cost. It is only in case of change of ownership, therefore, that a revaluation of site is usually found necessary. Buildings, on the other hand, may depreciate very rapidly, the term of life depending upon their design and solidity of construction, the material of which they are made, the quality of the workmanship, the climate, the usage to which they are subjected, and the thoroughness with which they are kept in repair. Buildings of brick and stone, subject only to deterioration from ordinary usage, may be written off very gradually, a rate of from one to two per cent. generally being sufficient. But, in the case of a building put to rougher usage, as, for instance, a foundry or smithy, a rate of four per cent. will be found more appropriate. Buildings of wood and iron require a still higher rate,—five to ten per cent. not being excessive in some cases. As a general rule, however, an average rate of two per cent. for a brick or stone machine shop, four per cent. for a brick or stone foundry, six per cent for ordinary iron buildings, and eight per cent. for wooden buildings, can be taken as fair, where repairs are properly looked after and are paid for out of revenue.

The effects of depreciation at these rates, including, also, that of 10 per cent. of each original $1,000 for terms of years advancing by steps of ten years up to one hundred, is shown in the following table, which, it is thought, will be found of assistance in the selection of appropriate rates for various types of buildings.

EFFECTS OF DEPRECIATION OF EACH ORIGINAL $1,000 AT DIFFERENT RATES, FOR TERMS OF YEARS.

YEARS.	2%		4%		6%		8%		10%	
10	817	07	664	83	538	62	434	39	348	68
20	667	61	442	00	290	11	188	69	121	58
30	545	48	293	86	156	26	81	97	42	39
40	445	70	195	37	84	16	35	65	14	78
50	364	17	120	88	45	33	15	64	5	15
60	297	55	86	35	24	42	6	79	1	80
70	243	12	57	41	13	15	2	95		63
80	198	65	38	17	7	08	1	39		22
90	162	31	25	37	3	81		65		08
100	132	62	16	87	2	05		28		03

The great diversity in rates of depreciation for the several distinctive types of assets enumerated in the foregoing will, I think, make it appear advantageous to deal with each group or classification individually by some such method as that outlined. Such division of capital not only simplifies the work of determining a fair valuation for partially-worn plant appraised for the first time, but affords one a much better opportunity of gaining in accuracy with each new readjustment of rate. For example, suppose that, after six years of service, it were found that the cone belts were not more than half worn out, and that, owing to a particularly dull year, the business showed a loss, which the directors wished to make good from the surplus earnings of other years. It would be an easy matter to change the rate to a one-twelfth reduction per year, and entirely permissible to consider the difference in value as profit—provided, of course, that everyone interested thoroughly understands from what source this additional capital is derived. It is often advisable to establish a high rate of depreciation for this very reason, as the amount set aside for wear and tear is, in one sense, a reserve fund, although in stock companies it is seldom wise to call it by this name, lest the share-holders should demand its distribution as dividend.

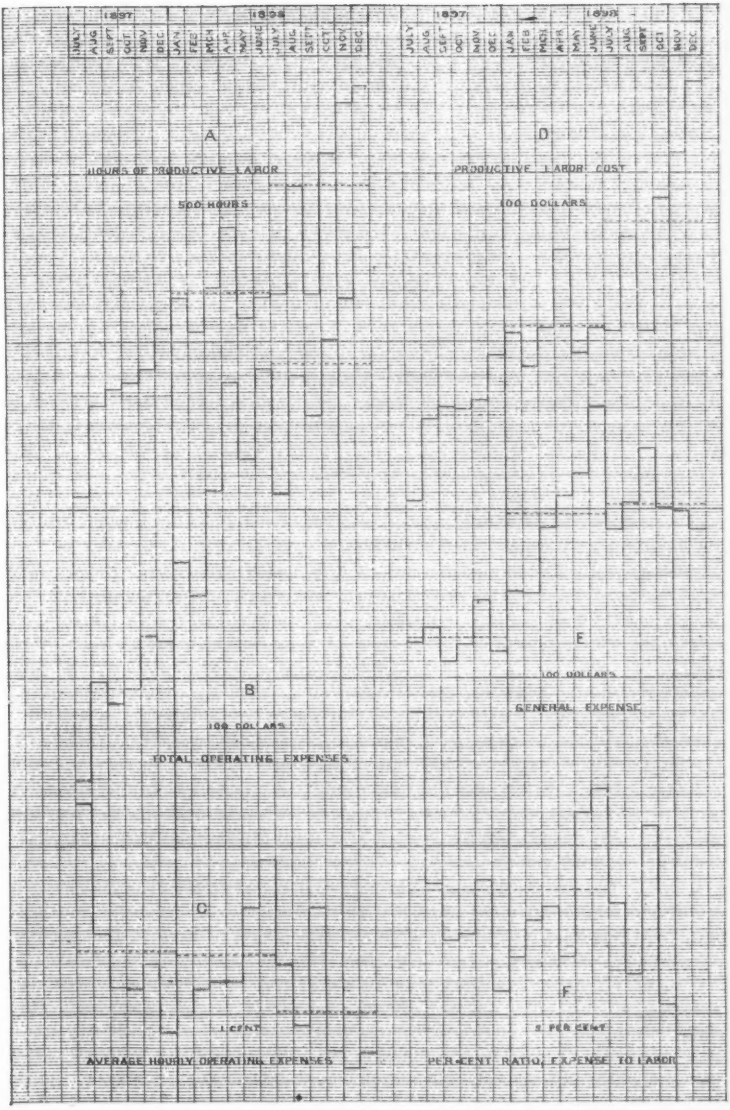
This brings us to a general consideration of the Expense Account, shown on page 394 of the December issue, the use of which form will now be patent to everyone. "Interest and Deterioration," item R, represents the results of the preceding year's inventory, and "Interest on New Assets," item S, the interest for the remaining months of the year on all outlays chargeable to Capital, the month upon

which report it appears. If a plant is valued at $150,000, and past records show that $15,000 per year is a fair amount to allow for deterioration, it is obvious that profits will not begin to accrue until $22,500 has been made over and above all actual disbursements—$15,000 for loss from wear and tear, and $7,500 to pay interest on the capital investment, making R $22,500 ÷ 12 = $1,875 per month. General expense is not met, therefore, until this sum has been fully provided for. This may be done in a variety of ways, the most common of which is the "Per Cent. Ratio" plan. Of this question, however, we shall speak later.

These reports are made out monthly, as explained in my first paper, after which the totals are converted into diagrams, or "curves." Unless one has a special aptitude for analysing a mass of complicated figures, it is very difficult to grasp the full meaning of comparative statistics without employing some method of diagrammatic notation to represent values. They are easily and quickly drawn, and may be read by the dullest of minds, the general tendency of the business, whether of growth or decline, being evident at a glance. They also show any unusual fluctuations that may occur from time to time.

In order to illustrate the enormous advantage which may be derived from the use of diagrams, I give on pages 83 and 85 the complete genealogy of the cost per hour of work made by my company from the time I took hold of the works in July, 1897, to January, 1899. The vertical divisions represent months, as shown at the top of the pages, while the horizontal divisions indicate hours, dollars, cents, or percentages, as the case may be. The small figures beneath the diagrams give the scale of each, or the reading between heavy lines, —i. e., the equivalent of every five fine divisions. Thus it will appear in Diagram A that the number of hours was increased 12,200 within the period from July, 1897, to January, 1899. The figures directly under the months show the percentage of over-time during each month, and the figures under them the number of working days in each. Over-time is given in actual hours, but is paid for at the rate of "time and quarter time," which fact should be kept in mind in making comparisons.

Columns 1, 2, and 3 exemplify each a distinctive method of figuring costs, and in column 4 the results are brought together for comparison. A shows total hours made by all producers; D, the total amount of wages paid producers; E, the total amount of general expense. Diagram B is the sum of "Productive Labor Cost," D, and "General Expense," E, which divided by "Hours of Productive La-



GENEALOGY OF MANUFACTURING COSTS.

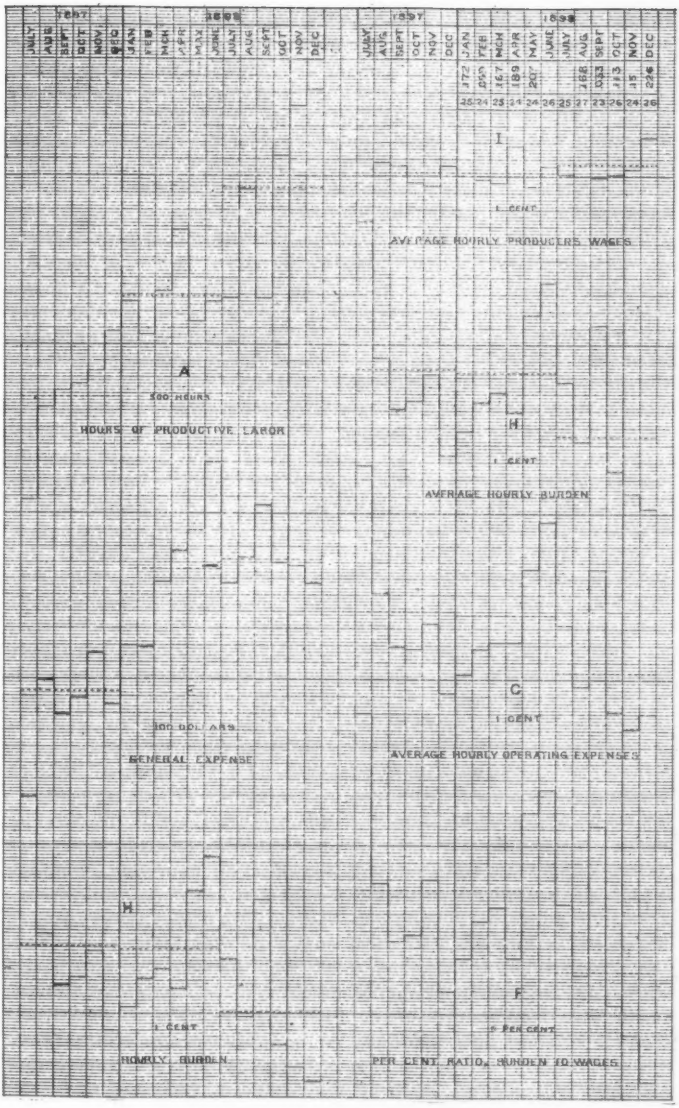
bor," A, gives the "Average Hourly Operating Expenses," C. Diagram F represents the results derived by dividing "General Expense," E, by "Productive Labor Cost," D, and shows the relation of Expense to cost of productive labor, while Diagram H is based on the figures obtained by dividing "General Expense" by "Hours of Productive Labor," and gives the relation of Expense to hours of productive labor.

There has been much discussion of late in regard to the relative merits of these three systems. Each plan has its advocates, and each is opponents. Which shall we accept as the fairest method of apportioning expense? The diagrams show the equivalents in each system. Thus, the month that General Expense was 82.87 per cent. of wages, the Average Hourly Operating Expense was $.3189, and the Hourly Burden $.1445. These figures furnish a definite and thoroughly reliable basis of calculation upon which to pass judgment, and, to my mind, answer the question at once. General Expense cannot be allocated to different orders by different methods. The plan that is used for the man must be used for the boy. Hence that system is best which, other conditions being equal, gives the fairest hourly charge for both high-priced and low-priced labor.

Suppose a workman whose rate is 30 cents an hour took 10 hours to do certain work; at what rate per hour must his time be charged, by the three systems, in order to make 20 per cent. profit on the job? What, also, would be the charge per hour, were his rate of wages only 5 cents an hour?

1.	$.3189	+ 20 per cent. =	$0.3826	cents per hour.	
2.	.30 + .1445 + 20	" =	.5334	"	"
3.	.30 × 1.8287 + 20	" =	.6583	"	"
4.	$.3189 + 20	" =	$0.3826	"	"
5.	.05 + .1445 + 20	" =	.2334	"	"
6.	.05 × 1.8287 + 20	" =	.1097	"	"

It must be borne in mind, in examining the above figures, that, no matter which system is adopted, the ultimate results are always identical. To multiply total hours made by producers in any period by the average hourly operating expenses for that period, which, in our illustration, is $.3189, is the same as adding its equivalent, or $.1445, to the hourly wages of each, or to increasing the wages of each by the other equivalent of 82.87 per cent. It is wholly a question of fairness of distribution of the General Expense Account. By the "Fixed Rate," or so-much-per-hour, plan,—lines 1 and 4,—the work-



GENEALOGY OF MANUFACTURING COSTS.

man's time would be billed at the rate of $.3826 per hour, regardless of his rate of wages; by the "Hourly Burden" plan,—lines 2 and 5,—at $.5334 or $.2334 per hour, according to his wages,—30 cents or 5 cents per hour; and by the "Per Cent. Ratio" plan,—lines 3 and 6,—at $.6583 or $.1097, depending upon the same conditions.

Custom has established a maximum rate of 60 cents per hour for the ordinary run of light work, beyond which one cannot go without risk of losing trade, except by special agreement. If, therefore, we can keep within this figure without the loss on either a high or low scale of wages, it is obviously best to do so. It is manifestly wrong to rate a man at the same figure as a boy, and equally unfair to charge 55 cents (difference between lines 3 and 6) an hour more for a man's work than a boy's, when there is a difference of but 25 cents in their relative rates of wages.

It will be noted that the figures furnished by the "Hourly Burden" plan—lines 2 and 5—come midway between those derived from the "Fixed Rate" and "Per Cent Ratio" plans,—lines 1 and 4, and 3 and 6, respectively,—which fact, alone, is, I think, a sufficient argument in favor of the superiority of the "Hourly Burden" plan.

The reading and comparison by means of diagrams of statistics pertaining to one's business is interesting in the extreme, and I regret that space does not permit an analysis of those shown in the illustration, the reliableness of which I can vouch for. Suffice it to say that, with such a set of diagrams before him, a manager can tell pretty nearly what is going on around him. He sees, for instance, by the dotted lines in Digram I, that, notwithstanding the marked fluctuations that occur from month to month, the average hourly wages for the six months ending June 30 are the same as the average for the preceding period. He knows, however, that wages are higher than they were a year ago, and that the averages could not be equal without a corresponding decrease in some other direction,—i. e., by the employment of a larger percentage of cheaper men, made possible by the more extensive use of jigs and fixtures. He turns to diagram A, and finds an increase of 3,050 hours between averages for these two periods. This increase in number of workmen should, he argues, show a proportionate decrease in fixed charges. He examines Diagrams H and F. The first shows a falling off of two-tenths of a cent; the second, nothing at all. With an increase between averages of $530 in cost of wages,—Diagram D,—the per cent. ratio should, under ordinary circumstances, have grown considerably less. Why has this saving not been effected? He looks at Diagram E, and

notes the rapid climbing up of the general expense account in the months from March to June. This does not please him. He had hoped for better results, despite the heavy expense he had been obliged to incur in the rearrangement of the shop during this period. He resolves to be more cautious the remaining portion of the year. He traces every leakage to its source, institutes such reforms as seem expedient, and watches every outlay with renewed vigor. The results are gratifying—the Hourly Burden, Operating Expenses, and Per Cent. Ratio, for the last six months, all showing a very decided falling off.

At the close of the year the twelve monthly reports are merged into one, showing the total outlay for each category of assets. These are then added to the depreciated value on the preceding year's report, as illustrated below, and the inventory taking, so far as the plant itself is concerned, is completed, which, I believe, is as far as I am expected to go.

	CLASSIFICATION.	1897	%	D. V.	1898	TOTAL.
A	Standard Drawings ...	4,000	10	3,600	1,500	5,100
B	Standard Patterns	6,000	15	5,100	2,000	7,100
C	Standard Machinery and Tools.....	30,000	8	27,600	10,000	37,600
D	Spec. Tools, Jigs and Fixtures	3,000	5	2,850	1,150	4,000
E	Line Shafting and Accessories	1,000	3	970	120	1,090
F	Office & Shop Fixtures.	800	5	670	130	800
G	Belting.....	1,200	15	1,020	280	1,300
H	Miscellaneous Plant...	500	10	450	....	450

THE DEVELOPMENT OF WOOD-WORKING MACHINERY.

By John Richards.

AS has been explained, forest sawing, or green sawing, as it is sometimes called, is in Europe a less important process in timber-converting than it is in the United States. Log sawing is carried no further than the reduction of timber to merchantable shape by removing the surplus wood and waste, so that the balks and deals will be in suitable form for transportation and for re-sawing at the timber yards, where they are reduced to finished dimensions as wanted.

This is, in several respects, a rational way of proceeding, which will, no doubt, be introduced into the American continent when timber becomes scarcer and dearer than it is now, and when the market and methods of selling are adjusted to such a system. The advantages are that the timber is not injured in transportation by breakage or exposure, and can be handled at half the cost when proper tackle is employed; there are no grit, dust, and season cracking to contend with, and the re-sawn timber can be furnished to customers bright and clean, and with accurate dimensions. Deals, which seems to be a name for any kind of squared pieces whose section is a parallelogram, form a unit from which two-thirds of common lists can be cut out with but little waste, as is proved by the small amount of *débris* found about saw mills in European cities.

It is commonly assumed that any sharp wood-cutting implement driven by steam power will displace enough shavings or sawdust to supply fuel for the power consumed, but this depends in a great measure upon circumstances. A coarse or thick saw may do this, but a thin one will not, especially when cutting slowly and accurately; but, setting aside rules, it is obvious that the waste of timber is measurable by the *débris* or offal in any kind of a wood-working establishment.

It may be remarked here, as a further digression, that furnaces for burning the dry *débris* from wood-working establishments are usually operated in a wasteful manner by attempting to control the fires, or the amount of steam generated, by the rate at which the fuel is supplied to the fires. This is not the best manner, or the most

economical one. The furnaces should be kept full of fuel, and the rate of combustion should be regulated by a damper. This dispenses with a great amount of care,—not always exercised, however—otherwise required in order to keep a regular supply of steam; it also avoids bare grates,—a common means of balancing the spasmodic effect of shovelling light fuel into a furnace under full draught.

A strong draught is required to open up the fires in case of choking, also in burning wet sawdust; but the draught should be continually under control, and its full force should be employed only in emergencies. It is an advantage in burning small *débris*, such as sawdust and fine shavings, to place on the grates a layer of re-

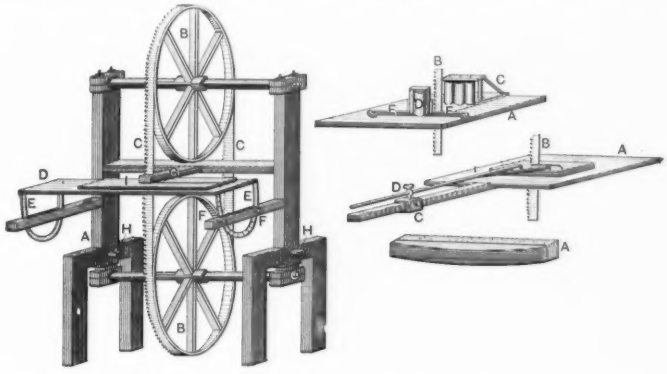


FIG. 1. THE FIRST BAND-SAW MACHINE.
(Patented by William Newberry in 1808.)

Has tipping table for sawing bevels, and feed rolls and radius gauge, showing a complete grasp of the capabilities of the invention.

fractory stone, broken into pieces small enough to prevent the unburned fuel from falling through the grates. These stones become red-hot, and serve to ignite fresh fuel, after the manner of a bed of live coals, and are no impediment to clearing the grates.

The characteristics of European log-sawing machines are, in most cases, massive framing; provision for sawing crooked timber; thin saws and slower feeding; a more careful support of saw plates of all kinds; and a wide use of machines for dressing saws.

The thickness of a saw is to a great extent determined by its size, or length, and this is governed by the dimensions of the logs to be sawn. The writer, on first visiting timber yards in northern Europe, could not get rid of the impression that the round timber was all

culls or waste. A raft load of logs in the Gotha river in Sweden was thought to consist of telegraph poles. It happened to be a collection of small timber even for there, and a visit to the Pacific coast of North America, soon after, still further emphasized the enormous difference in the timber resources of the two countries. Soon after arriving in San Francisco there was encountered in the street a squared beam of fir more than a hundred feet in length, being hauled to a factory in course of erection. Following this beam to its destination,—a woolen factory then being built,—it was a matter of astonishment to find all the longitudinal beams, or "stringers," of the same length. This astonishment was increased when the contractor said: "We never bother about dimensions, and just order what

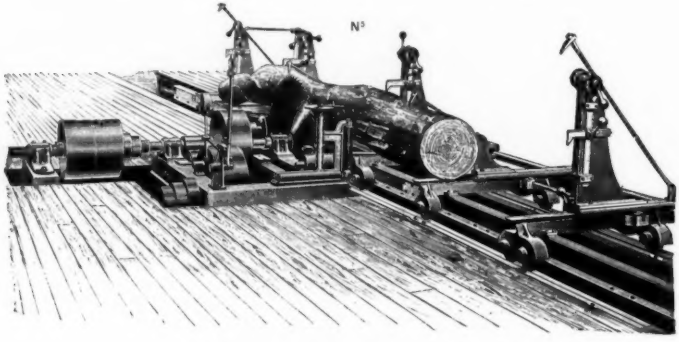


FIG. 2. FOREST SAWING MACHINE

An adaptation of the American circular mill, but of heavier proportions and adapted to irregular lumber, such as shown. These machines are intended to be taken to the woods to saw the lumber where it is cut.

we want." A section eight feet in diameter, cut from a redwood tree, completed a new impression of American forest timber.

The illustrations in this chapter show, in several cases, logs being sawn, and these will serve as common examples of the hardwood timber found in European yards. Considering such diversity as this in the material to be operated upon, the distinction in machines, disclosed in the drawings, will seem trivial.

The care of saws, mentioning as a distinguishing feature of European practice, is a refinement. For twenty years past there has been but little use of files for this purpose. About twenty years ago there were invented and put in use various modifications of machines for sharpening saws, both straight and circular, that saved a good deal in the expense of sharpening; but this was not the chief end attained.

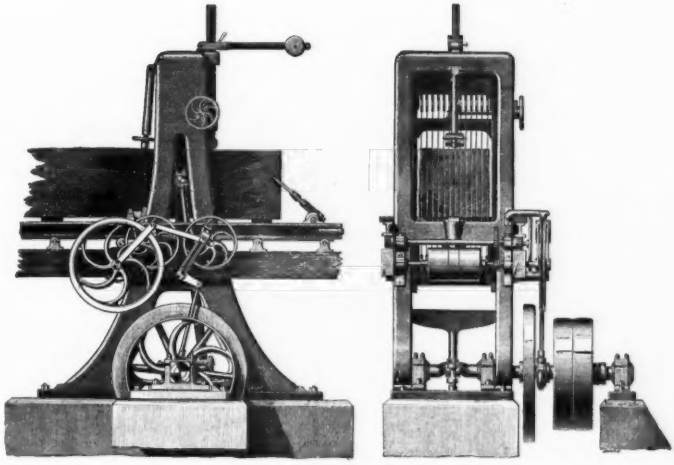


FIG. 3 GANG SAWING MACHINE

Standard gang sawing machine with carriage outside the main frame, and with friction rack feed. Adapted for sawing balks or squared logs.

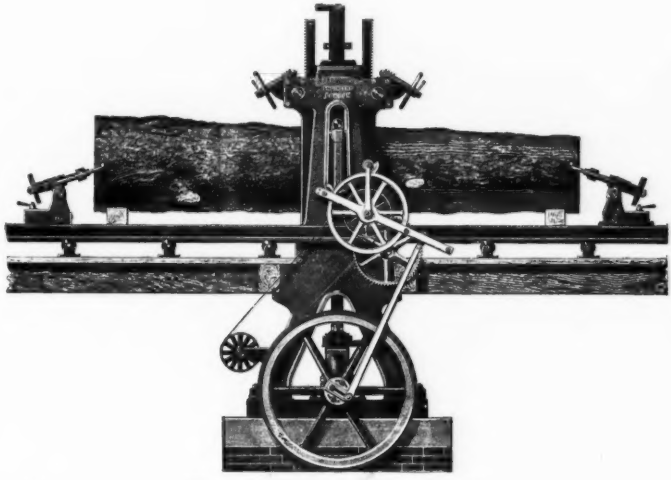


FIG. 4. LARGE GANG SAWING MACHINE.

A heavy gang sawing machine with carriage and rack-and-pinion feed and top bearing rollers.

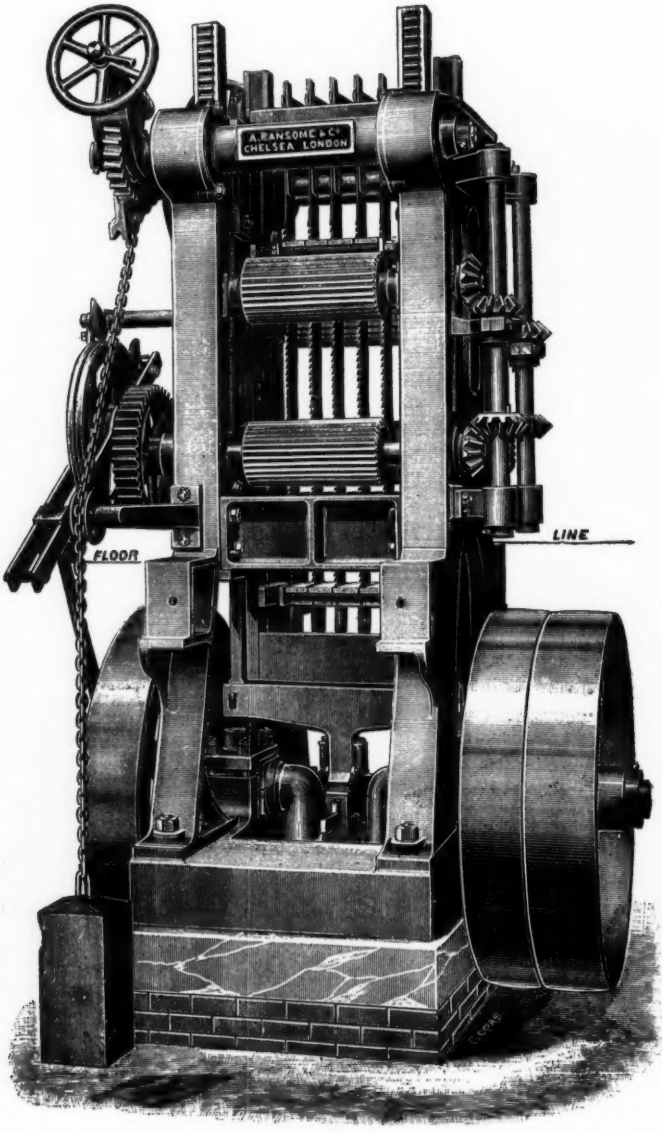


FIG. 5. DOUBLE-ROLLER GANG SAWING MACHINE.
Both upper and lower rollers are driven, thus furnishing a powerful feed. The centre crank shaft is of forged steel, and all parts are well proportioned and heavily built.

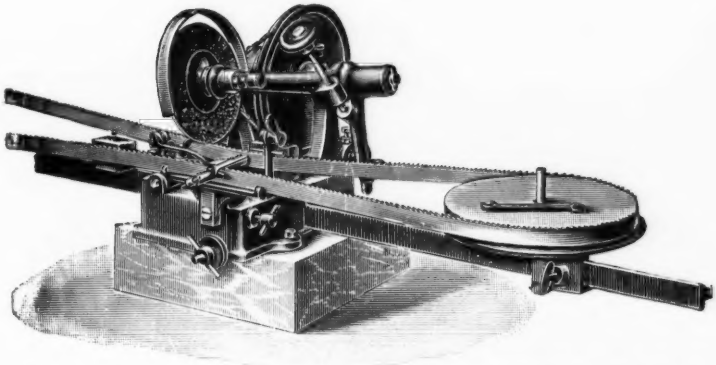


FIG. 6. AUTOMATIC SAW-SHARPENING MACHINE FOR WOOD CUTTING SAWS HAVING STRAIGHT TEETH.

Adaptations of the machine are arranged for circular and gang or frame saws.

The main thing was the truth of the saws, which divided the work equally between the teeth.

It would be difficult to convey in words an idea of the difference in working between a saw that is perfectly round or straight and one that is not. A sawyer knows by the "feel," the moment a saw touches the wood, whether the teeth are true. The sound is different; so also is the result; and even the greatest care in hand-filing will not produce an effect like that of machine-grinding, because the teeth are separately dressed, depending on sight, and re

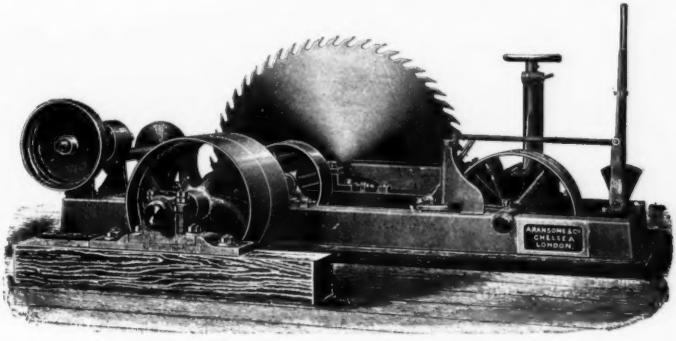


FIG. 7. CIRCULAR SAWING MACHINE FOR LOGS.

A combination of the European "rack saw" and the American "circular sawmill." The packing boxes are shown along the front side of the saw.

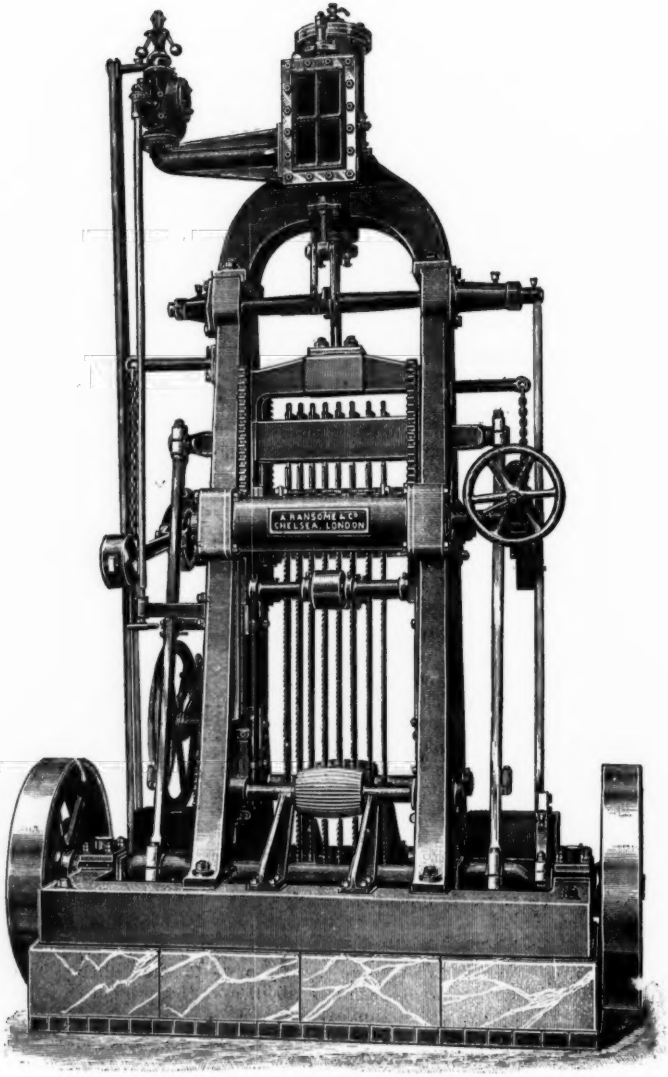


FIG. 8. DIRECT-ACTING GANG SAW MACHINE.

The frame carrying the gang saws is operated directly by the steam cylinder above, the stroke being controlled by the crank-shaft below. There is a roller feed, and the machine is self-contained and adapted for erection anywhere.

quire frequent jointing, or grinding off of the points, while the saw is in motion.

The steel thus wasted is commonly a good deal more than that consumed by the wear of cutting, so that half the cost of saws is lost; besides this, hand-filing is commonly done at the points of the teeth alone. The gullets, or spaces between the teeth, soon become too shallow to hold the sawdust, and the saws require "gumming"—formerly done by punching out between the teeth, which left the saws with inherent strains and frequently with cracks.

The grinding of saw teeth with emery wheels is no doubt extensively practiced everywhere now, but the filing process continues to a great extent where machines would be much better. Such machines, when well made and provided with the required adjustments, cost a good deal, but, when the waste of files and of the steel lost in jointing is taken into account, it is seen that the cost of a good machine is soon saved.

So much has been already explained respecting the importance and manner of re-sawing timber in European yards that but little remains to be added, except illustrations of the machines; and even this requires but little in the way of explanation or remark, because

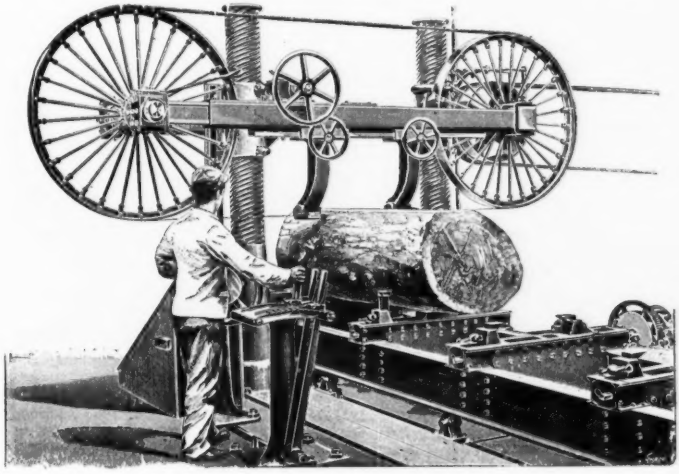


FIG. 9. HORIZONTAL BAND-SAWING MACHINE.

A unique form of machine of doubtful advantage—the whole machine being moved for adjustment, instead of the log. The horizontal position is not favorable to the best action of the saw.

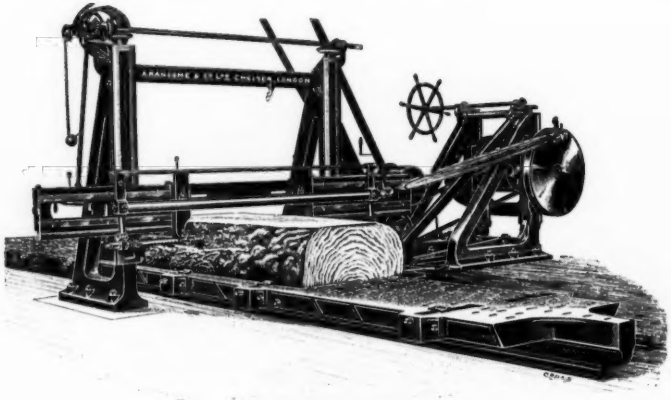


FIG. 10. HORIZONTAL SAWING MACHINE FOR LOGS.

Designed for reducing logs of fine wood at a slow rate, but not so well adapted for this work as is the band saw.

the machines in common use are practically of one type—light gang saws adapted to run at high speed.

Such machines are the result of "natural selection," free from complication, quickly adjusted, and, when the number of cuts or kerfs are three or more with a single machine, or four to six with a

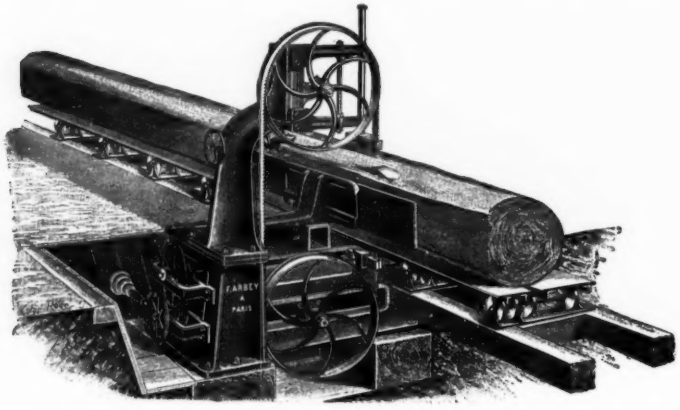


FIG. 11. BAND SAWING MACHINE FOR LOGS.

An example of early French practice, peculiar for its split-rack carriage and gauge plate, and illustrating the type of machine built in France for use in South America, etc.

double machine, the speed of performance is such as to meet all the requirements, economic and other, that arise in practice.

The gang of saws can be changed from one dimension to another in a few minutes, and, when there are several machines available, as is common in the larger timber yards, a list of "stuff" can be cut out as fast as it can be measured or counted and loaded on wagons.

With the equilibrium type of machines having two saw frames that move oppositely, the speed can be from 350 to 400 strokes per minute, which, with only four saws, gives a cutting movement of the

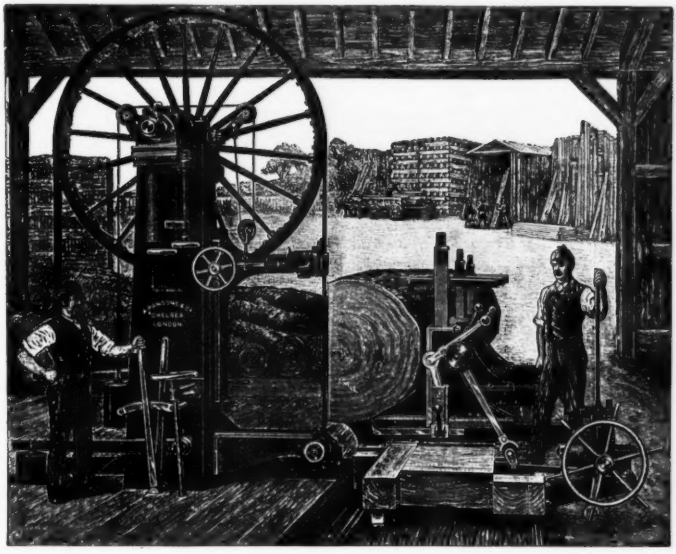


FIG. 12. LOG BAND SAWING MACHINE.
One of the most complete log band mills built in England, closely modelled after American designs, and representing good English and American practice.

teeth equal to a thousand feet per minute. Both circular and band saws are employed in re-sawing, but not to a great extent. The evolution of the latter, which has taken twenty years or more in the United States under what may be called "high pressure effort," has not proceeded so fast as in Europe, where the timber is more obdurate and experiments are more dreaded.

Why reciprocating re-sawing machines, or deal frames, as they are called in England, have not gained a place in American practice is not easy to explain; the probability is that, if in large cities, some

timber-yard owner would provide a set of such machines and cut out to order for his customers such sizes as are wanted, the business would be profitable. It would, for one thing, save much expense and waste in planing, as planing would be unnecessary except for surfaces to be painted or varnished.

Prominent among wood-working machines, and the first to relieve workmen of heavy drudgery, are saw benches,—machines con-

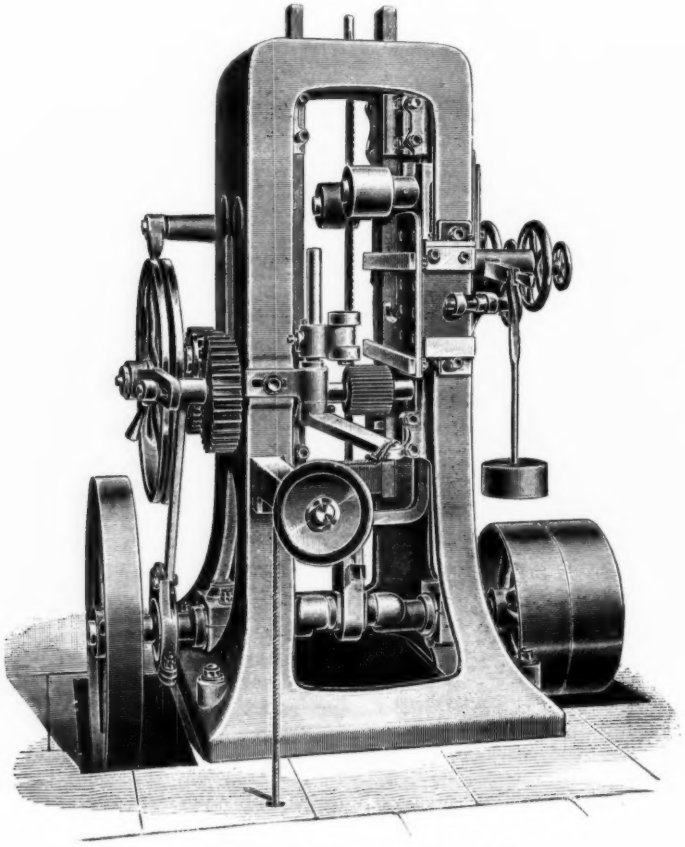


FIG. 13. SINGLE-FRAME RESAWING MACHINE.

Arranged with roller feed for resawing deals to dimension sizes. A typical English machine.

sisting essentially of a bench with a circular saw projecting through the top and adaptable to a wide range of purposes.

In these machines, as in most other classes, there is wide divergence between American and European practice, and in the uses to which the machines are applied. Practice or design arises out of uses or adaptation, and this accounts for many differences between the machines, as will be explained further on.

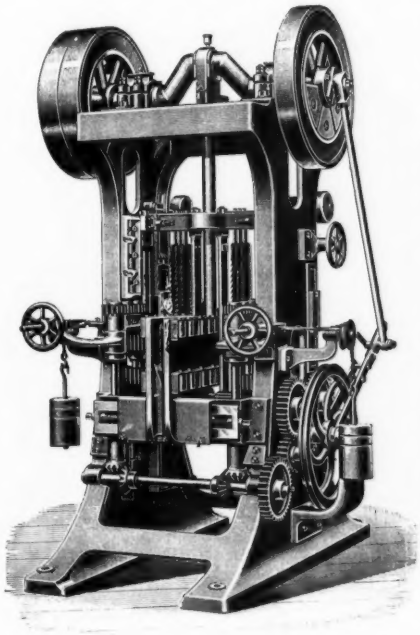


FIG. 14. DOUBLE-FRAME RESAWING MACHINE.

Arranged with vertical and horizontal feed rolls, and adapted to receive two deals, one at each side, with a gang of saws for each.

Saw benches in the United States are commonly made for light work, such as cross cutting and ripping boards and planks; but in Europe they are employed for heavier work, and are provided with saws four, and sometimes five, feet in diameter. American saw benches are nearly all for hand-feeding, and in Europe nearly all have some kind of gearing to feed or advance the timber — an indispensable feature for large and heavy pieces, such as round logs up to 18 inches' diameter, which are sawn there on benches.

This term saw bench is a flexible one in its application in Europe, and, as the illustration will show, is applied to machines that in America, would be called "saw mills;" in fact, the term bench is applied to almost any kind of a machine for operating circular saws. Saw benches are made in a heavy substantial manner, the spindles being large and fitted in gun-metal bearings, and the frames being cast in one piece.

There are some features in European saw benches that could

with advantage be adopted by American makers, and will have to be, if saw benches ever become an article of export trade. One of these is the method of arranging the fences, or gauges, that guide the timber. In respect to these, it may be noticed that in all of the European machines these gauges do not extend much beyond the teeth at the front edge of the saw, and it is not easy to find any reason for making them longer. Evidently the timber should be free laterally after it is sawn, or behind the cutting teeth, because no guidance or direction of its course beyond that point is possible or required, and a gauge extending back past the saw, if straight, must be set obliquely to the saw, to prevent crowding the teeth at the rear.

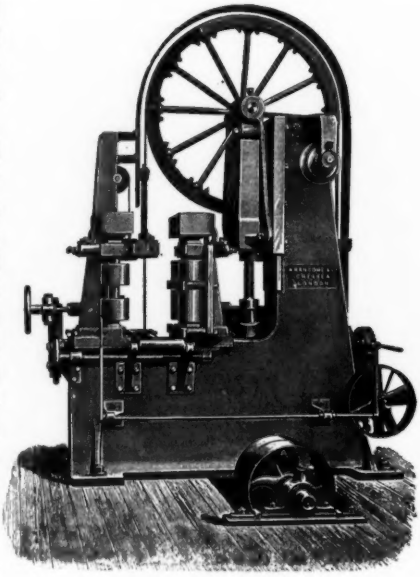


FIG. 15. BAND RESAWING MACHINE.
A substantial machine of moderate size, representing English practice. Band resaws are not so much used in Europe as in America, the deal machines being preferred.

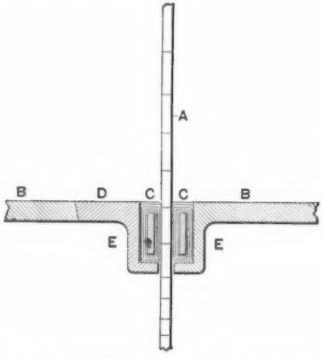


FIG. 16. PACKING BOXES FOR CIRCULAR SAWS.
The fibrous packing is fitted into cavities in the table, and serves to retain a lubricant as well as to steady the plate.

In Europe the saw gauges are made with a loose, or adjustable, face, which can be set parallel to the saw, both horizontally and vertically, and moved forward or back to suit large or small saws, so that the gauge will not extend beyond the teeth at the front and that a piece, as soon as sawn through, will be free at both sides of the saw and can be removed

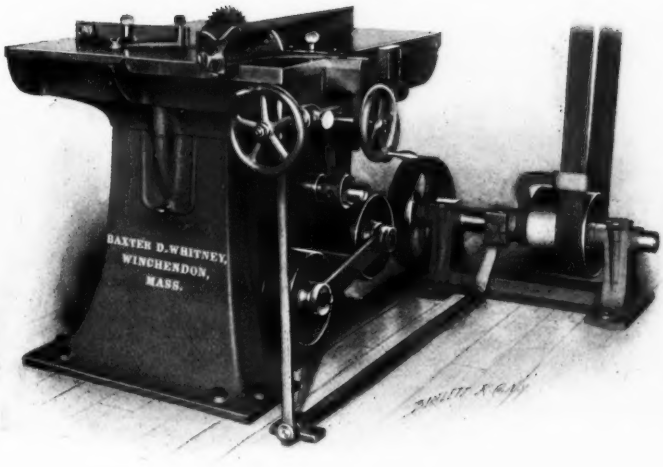


FIG. 17. DIMENSION SAWING MACHINE.

With ripping and cross-cut saws, adjustable to any position above or below the table, and with guides and gauges for the most accurate kind of dimension sawing.

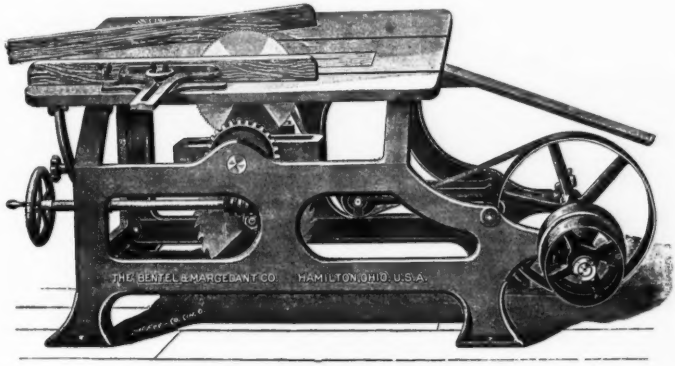


FIG. 18. COMPOUND SAW BENCH.

The ripping and cross-cut saws are mounted on a frame, so that either one can be projected through the table to various depths, and adapted for a variety of work.

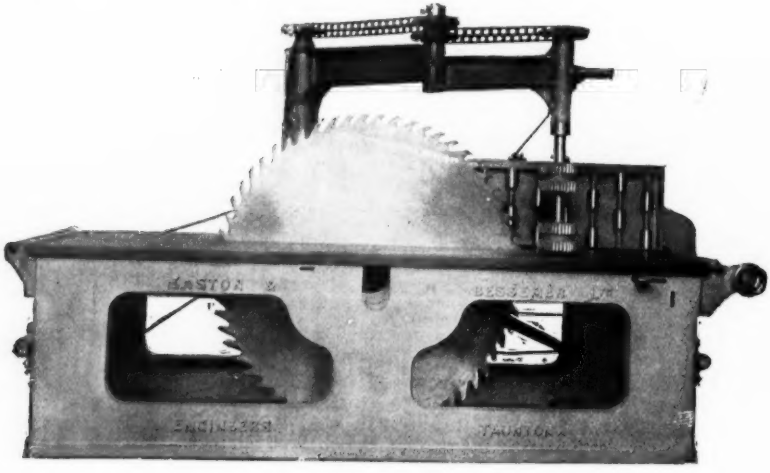


FIG. 19. CIRCULAR-SAW BENCH WITH IMPROVED SELF-ACTING CONTINUOUS FEED.

without the dangerous operation of pulling it out from between the gauge and the saw.

Another feature is what are called packing boxes at each side of the saw, in front of the saw collars, as seen in Fig. 16. It is because of this device that circular saws are made much thinner in Europe than in America, and are driven with less power. Saws 36 inches in diameter are sometimes made as thin as No. 14 by the wire gauge, and are rarely thicker than No. 12. The packing boxes

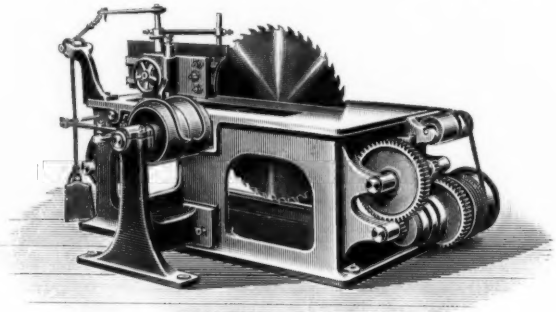


FIG. 20. SELF-ACTING SAW BENCH.

Constructed with rope feed, and representing a class of machines in extensive use and of remarkable performance.

have two functions: they support and steady the saws, and keep them lubricated. If a saw is crowded laterally, or is pinched by the timber, it instantly heats, and this melts or thins the oil in the packing just when it is needed.

Considerable space is taken up by illustrations of European saw benches, and a good many readers will be at a loss to know why these machines have such prominence, and are so heavily constructed. An explanation of this may contain useful suggestion. In America most establishments using timber in their manufactures purchase the material sawn into boards, planks, and scantlings. In Europe timber is commonly purchased in the log, by the cubic foot,

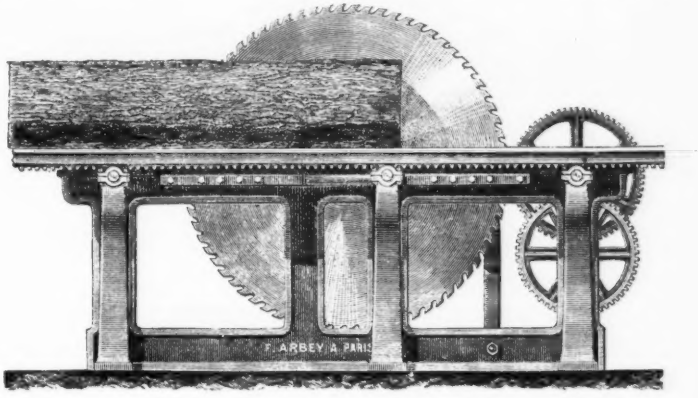


FIG. 21. HEAVY SAW BENCH WITH RACK FEED.

The table is in two parts, one on each side of the saw, both being moved simultaneously by shaft, pinions, and racks.

and is sawn as wanted to the particular sizes needed; hence the necessity of these powerful saw benches.

The writer has reason to believe that the European plan is best, and might be adopted in the United States, with many advantages, and in this belief he brings to his aid an experience as mechanical manager of a large company at Columbus, Ohio, that consumed yearly about 60,000 to 100,000 cubic feet of hard-wood timber of various kinds. Experiments were made in purchasing a portion of this timber after it had been sawn at the mills, with the result that the cost was nearly doubled and the quality obtained was decidedly inferior. In the end all the stock consumed was cut from logs of oak, beech, hickory maple, and ash woods, and, strange to say, experience and "natural se-

lection" led to the use of specially-designed saw benches, closely corresponding to those in the last five figures of the illustrations, but less complete and efficient.

The logs were received in short lengths, split when too large, and were sawn with the grain, and also with respect to the growth, —a method which produced better material; they also could be selected, and apportioned to suitable purposes. Two men could easily saw into small sizes five cords, equal to 6,000 feet, board measure, in a day, cut accurately to the dimensions wanted. The waste furnished fuel for the works and left a surplus that could be sold for $300 to $500 a year.

It is possible, in almost any part of the United States, to purchase hard-wood timber by the cord, or cubic foot, at a low price compared with that of sawn material. It is evident that the hauling to saw mills, the sawing charges, and the hauling again to a place for shipping, must cost about half as much as the timber. It is also evident that quality must be inferior when the material is sawn into flitches without regard to growth or grain. In the case spoken of, and in others at the same place, where extensive manufactures in wood were carried on, it would have been preferable to purchase the timber in the log, if sawn stuff could have been obtained at the same price per cubic foot.

It is common to hear it said by consumers of hard-wood timber: "We do not want to trouble with a saw mill;" but, as the illustrations of European saw benches will show, a saw "bench" is all that is required, if it be properly made and strong enough for the work.

THE PROSPECTIVE EXPANSION IN AMERICAN SHIP-BUILDING.

By G. R. Dunell.

THE British ship-builder who keeps an intelligent eye on industrial progress abroad sees nothing much plainer just now than that he will be, probably before very long, face to face with serious competition from the United States. The prospect is not a pleasant one, and therefore he will avoid facing it as long as possible. But it is inevitable in the nature of things, for there are natural laws which govern economics just as there are natural laws of another kind which direct physical phenomena. The great rivers flow in dependence on these natural laws. Man may meddle a little here and there,—erecting a dam or straightening a channel, imposing a tax or granting a bounty,—but the rivers keep to their valleys, and the streams of commerce roll just where the natural conditions are most favourable, in spite of petty obstructions such as legislative enactment or protective tariff and fostering bounties.

For ship-building and marine engineering (which is a part of ship-building largely considered) natural conditions are becoming exceedingly favourable in the United States. We find there, first of all, a race ingenious, resolute, ambitious; a people who have been, by the working of nature's two great laws, survival and heredity, fitted to grapple with large problems and win success in the face of difficulty. That is the first requisite, without which the rest is of no avail. Nature has also given this nation a long coast line, harbours, and those mineral riches which are now the raw material of the ship-builder. These conditions being present, the Americans, in becoming ship-builders, are but working out their natural destiny.

The Americans have once already shown themselves well fitted for maintaining a ship-producing industry. This was in the days when mechanical propulsion was in its infancy,—when steam engines were not a very serious factor in the ocean freight trade of the world. But who doubts the mechanical genius of the Americans? by their boldness and originality in engineering conceptions so much the more are they now fitted for the work of sea-carriage in these days of universal steam propulsion. When America formerly held a high position as a ship-building country, she had raw material in abundance, her forests af-

fording a plentiful supply of timber. Her well-designed ships then furnished models which the British were fain to copy; and the fearless manner in which the ship-owning firms managed their business subjected British enterprise to a test such as it had not before been put to, and has never experienced since. Artificial restraints—those dams to which I have already made reference—did something to destroy, or perhaps, rather, check, the career of the ship-building industry in America, but natural causes have contributed immeasurably more to this end. When iron, and later mild steel, became the materials for ship construction, it was not in the nature of things that America should produce them, for the natural laws of the industrial development are not to be unduly hurried, any more than those governing physical phenomena, and the country was not then ripe for iron-making on a big scale. The energies of the people, great as they were, had been engaged in other directions. The vast mineral riches of the continent were unknown, or, if known, were not in a position to be utilized. No one can doubt, however, in spite of the depredations of the Alabama, that, had the United States possessed an iron-making industry equal to that of England after the close of the civil war, the national qualities which enabled the country to compete so successfully in the days of wind-driven wooden hulls would have kept her flag floating beside the red ensign in the ports of the world.

These things are worth considering by the British ship-builder and the British ship-owner just now, for, if they look across the Atlantic, they find that this great bar to the establishment of a modern American ship-building industry, the lack of raw material, has recently been removed. In 1890 the president of the Iron and Steel Institute, Sir James Kitson, addressing an American congress, said: "The supremacy of our (British) ship-builders and our shipping interest is based upon the excellent quality and the abundant supply at moderate prices of steel furnished by our steel makers." Now the United States produce more pig iron—the primary raw material of steel, and therefore of ships—than any other country in the world, not excluding the United Kingdom. This matter lies at the root of our subject.

Pig iron, as has been said, is the chief raw material of the ship-builder; that and timber, of which there is plenty in America, a little copper, of which there are also excellent native supplies, paint, varnish, and some other accessories, are all that are needed for ship construction and marine engine building. Iron, however, is the dominant factor, the term, of course, including that description of iron known as mild steel, but more properly called ingot-iron. Going

back thirty years, we find that the production of pig iron in the United States was 1,431,250 tons in 1868, while during the same year Great Britain produced 4,970,206 tons. In 1897 the total production of pig iron in the United States had increased to 9,652,680 tons, while for the same year in the United Kingdom the total was 8,789,455 tons. Thus we see that, while Great Britain was roughly 3,500,000 tons ahead of America thirty years ago, twenty-nine years later she was not very far from a million tons behind. It was in 1890, the year of Sir James Kitson's address, that America first forged ahead, and, except in 1894, she has kept the lead ever since.

It is not all pig iron, however, that is suitable for ship-building purposes. But this remark would have possessed greater weight ten or twelve years ago, and is likely to possess less in the future than it has at present. This is to say, the spread of the basic process of steel making appears likely to bring us nearer, so far as the utilisation of native products is concerned, to the conditions which were present when iron, and not steel, was used for ship-building; for we can now use in basic-lined furnaces those phosphoric or non-bessemer ores which are not admissible with the acid process. When ships were made of wrought iron, as they were for many years after the first year we have dealt with, any country producing a fair iron ore was able to convert it into good ship-plates, angles, etc. In those days England claimed that her engineering and ship-building trade held an almost impregnable position, because iron-stone, coal, and limestone were in close juxtaposition, and that, too, near the sea, Though other countries possessed these minerals, they were more or less widely distributed, generally inland. Freight had to be paid on one or more of them, thus bringing up the cost of production. In those days, too, the notion that there was something native to the "right little, tight little island" which would always enable Britons to defy the world in such matters had not received the unpleasant jars which it has since experienced.

However this may be, the facts as to geographical distribution, or, rather, concentration, of materials were true, and the arguments founded on them were sound at the time. Since then what a change we have seen! The very practice in engineering which Englishmen initiated has wrought such wonders in annihilating distance that coal, iron ore, and limestone, though long distances apart and hundreds of miles from the sea-board geographically, commercially may be close together and within easy reach of a port of shipment. On the American continent this has been due chiefly to the wonderful development

of the railway,—a matter we shall refer to again later,—while on the ocean the work has been almost wholly British.

Another step, besides easy freight, was needed to shake the comfortable British supremacy founded on iron, coal, and limestone in narrow compass; and this step was brought about also by an Englishman, who thereby put the ironstone of his native country out of the market so far as shipbuilding was concerned. When Henry Bessemer was struggling to introduce his great invention, with courage as true and a will as firm as his own steel—fighting the world of science and industry to establish his process,—he was an unconscious servant of destiny, initiating a change destined to alter the whole aspect of a great industry, and to cause a shifting of the basis of iron making that now, after many years, gives an opportunity to the rivals of his native country. British ores, for the most part comparatively rich in phosphorus, were nevertheless suitable for the production of wrought iron, but were quite unfitted for the manufacture of mild steel by the acid process,—the only process known until long after. Great Britain had only a few deposits of non-phosphoric or bessemer ores, and thus it came about that, so far from getting ore, coal, and limestone from one district (it is said that occasionally all three have come out of the same pit), she has, during many years past, been sending hundreds of miles across the ocean for very nearly all the iron ore that is smelted and worked up for ship construction.

If we turn again to statistics of the British iron trade for the year 1897, we find that, of the 8,789,455 tons of pig iron produced in Great Britain, 2,601,806 tons were devoted to the production of open-hearth steel ingots. In the United States, during the same period, the production of open-hearth ingots amounted to 1,631,843 tons. Now it is hardly necessary to say that open-hearth steel is that description from which ships are built. It must not be confounded with bessemer steel, which is the product of the converter, but it was Bessemer's invention which led to the introduction of the open-hearth process, which we owe chiefly to a Frenchman, Martin, who adapted Siemen's furnace to steel-making purposes. Though the American output of the open-hearth steel falls considerably short of the British, it is amply sufficient to prove that the production can be increased when the demand arises; indeed, it is increasing, year by year, in a very substantial manner. If confirmation of the ability of America to supply raw material for ship-building be needed, witness the fact that American steel makers have been rolling ship plates for the British market.

There are, it is true, special reasons for the import of such mate-

rial into England, or, rather, Ireland, just now,—reasons which may prove of a transitory nature. This, however, it is fair to say, is not the opinion of some Americans connected with the steel trade, who are sanguine that they will secure a substantial share of the business in England; and certainly the experiment is not being looked on with indifference by British steel makers. The bringing of steel plates, angles, etc., across the Atlantic appears, however, too much like directing the stream of commerce into artificial channels ever to gain permanence. In any case, if Great Britain should have to rely to any extent on a foreign source of supply, there would be a poor prospect for her in the building of ships. Such an eventuality, is not, however, what we have now to consider; the question being rather whether America can supply herself with manufactured steel for ship-building on terms equal to those existing in Great Britain.

Turning again to our table of statistics, we find the production of open-hearth steel divided into two classes, acid and basic. As is well known, the basic process was an English invention, but has found more favour in foreign countries, notably Germany, than in the land of its birth. Of the 2,601,806 tons of open-hearth ingots produced in Great Britain during 1897, not less than 2,393,718 tons were made with the acid process from non-phosphoric ores, mostly imported, thus leaving only 208,808 tons to the basic process. In the United States, on the other hand, during the same year, out of the total of 1,631,843 tons of open-hearth ingots, 1,075,689 tons were of basic steel, and only 556,156 tons were of acid steel. It may be added that during 1897 Germany produced 1,304,423 tons (metric) of basic open-hearth steel. This was made largely from native ores very similar to the large British deposits, though a good deal of highly phosphoric ore, rich in iron, is imported

In the early part of this year an English engineer well acquainted with American metellurgical practice, Mr. Archibald P. Head, of 47 Victoria street, Westminster, read an extremely interesting paper on "The American Iron and Steel Industry." In this valuable contribution the author not only showed to what a remarkable extent the Americans were forging ahead in the iron-making industry, but also gave details of the way in which they gained their end. Many of the advantages they possess are the result of physical conditions, but not a few are due to natural characteristics—enterprise and that rare intelligence which makes scientific discovery minister to commercial success through the channel of wise and liberal expenditure.

The net result of all these conditions is that not only pig iron,

but manufactured iron and steel, can be produced more cheaply in the United States than in Great Britain, and that to an extent of which few not connected with the industry have any idea. Thus, to quote Mr. Head's figures, bessemer ore could be sold in Pittsburg at 11s. 6d. per ton, while the price in Middlesborough was 14s. 9d. This, however, is not all, for the American ore has 63 per cent. of iron in it, while the Spanish ore used at Middlesborough has, say, 50 per cent. Here there is an advantage for the American steel maker at the start, for he has his ore brought to the coal and limestone at 3s. 3d. per ton less than the price at which the Englishman gets his. In both cases long distances have to be traversed, and the American has the great disadvantage of land carriage. But the American railway engineer has made so good use of his opportunities that the railway rate for minerals is less than half that in Great Britain, and often very greatly below that figure. Of course Bilbao ore has practically no railway carriage in transport to Middlesborough, while the ore for the Pittsburg furnaces is taken some distance by train. If the American freight trains were run upon the English goods system, the 11s. 6d. paid for iron ore in Pittsburg would be considerably increased.

Continuing with Mr. Head's figures, we find American coke 6s. 6d. per ton as against 13s. 6d. for Durham coke, and, although the United States fuel has not the appearance which a Durham maker considers indispensable, it gives good results, being hard and bearing the burden in the blast furnace very well. Coal is notoriously cheap in Pittsburg. Mr. Head gives steam coal at 3s. per ton, which is much below the prices that rule in England. As a result of these and other conditions, bessemer pig is produced in America at 40s. per ton as against 50s. per ton* for the Middlesborough pig. Non-bessemer pig is given as 38s. 9d. for Pittsburg and 40s. 9d. for Middlesborough. Having read these figures, we are not surprised to find the price of steel ship plates to be £4 12s. at Pittsburg as against £5 10s. at Middlesborough, though, in considering these quotations, it must not be forgotten that ships can be built at Middlesborough, while the Pittsburg plates would have a long journey to make to the ocean ports. For boiler plates the prices given are £5 10s. 6d. in America and £6 10s. in England.

There are two matters to both of which the sturdy and optimistic British ship-builder is apt to refer when one speaks of the danger of American competition. These are dear labour and protection, the

*These figures are averages, taken from Mr. Head's paper. They naturally alter from time to time.

former being looked on as the result of the latter. But protection in America, as we have seen, has not had the result of raising the price of raw material for ship-building above that which rules in England —a free-trade country. As we are not discussing political economy, we may let that matter rest for the present. It may, however, be useful to point out that the United States, as a vast industrial continent,—a world almost in themselves,—are essentially free-trade. If ore from Minnesota or Wisconsin had to pay duty on going into Illinois or Pennsylvania, and if New York or Massachusetts imposed a heavy duty on Illinois and Pennsylvania plates, beams, and angles, the chances of American ship-building would fall to a low ebb. But if, for a minute only, we consider each State of the Union as a separate country, we find that there is no parallel in the world to the extent to which free trade prevails on the American continent; and there is certainly no other equal area of the globe, comprising so vast and varied natural resources worked industrially, that is without the bar of customs and tariffs.

The two great items of cost to a ship-builder are labour and materials. The latter we have dealt with so far as the limits of our space and the nature of this article permit; upon the former we must say a few words. Undoubtedly wages are higher in the United States than in Great Britain; and this is true of both "tradesmen" and unskilled labourers. Mr. Head gives 19s. a week as the wages of the latter in England, as against 25s. a week in America, and this may be taken as a fair basis of comparison, both for the artisan and the labourers of the two countries respectively, the difference being roughly 25 per cent. to 30 per cent. Now, it is difficult—in fact, impossible—to put on paper concrete facts and figures in support of what I am about to state, but I am confident that few—I had almost said "no one"—who have had experience of both the European and the American mechanic will doubt that the American employer gets more than value for the extra money he pays. The British ship-builder who disbelieves in American competition—almost necessarily an untraveled British ship-builder—does not take this view. "There is," he says, "necessarily so much unskilled labour in ship-building, labour where brawn counts so far above brain, that wages must always tell in the end. Moreover, ships and marine engines are not like bicycles, where automatic machine tools can cut them out of a few lengths of tube and a few rolls of wire." No doubt the genius of the American engineer for labour-saving is most apparent in the "repetition work" involved in the production of bicycles, sewing machines,

type-writers, etc.; but a ship-builder need be by no means elderly to be able to look back on a good deal that has already been done to substitute mechanical appliances for hand labour in his own trade.

Nevertheless the average ship yard is a rude affair. It is true that plates are not holed with a hand-punch, or divided up with a cross-cut chisel, but the punching and shearing press, with a few uncared-for drilling machines, appear to be the highest flights of mechanical science to which a good many ship-yard managers are capable of soaring. This state of affairs is largely the result of what has been almost a monopoly in ship-building possessed by Great Britain. Absence of competition has told its invariable tale. This result has also largely been due to the "rushes" and "booms" to which the ship-building industry has so long been subject. Yards are overcrowded with work for a time, and then all but empty for an equal period. Either there is no time to introduce improvements, or no money is being earned to make them worth while.

I would add a few words to prevent misconception. From a naval-architectural point of view the science and practice of ship-building has been brought to a high state of perfection in Great Britain, chiefly owing to the influence of the Institution of Naval Architects, which numbers in its ranks a body of men unequalled as ship designers. The various questions of fluid resistance, stability, strength of structure, and other professional problems are studied and discussed with a scientific knowledge and practical grasp leaving little to be desired; but the average naval architect is no mechanical engineer, and what little attention he bestows on the subject is devoted to the marine engine. Hence it is that the ship-yard plant had been too much relegated to persons of small authority and smaller pay. Those who know of the trouble the late Ralph Tweddell had in trying to introduce hydraulic appliances for ship-yard use will appreciate this part of our subject. No thoughtful engineer can go through an ordinary ship yard and see the gangs of men carrying, lifting, pulling, and hauling, without feeling sure that much might be done in the way of improvement. It is in this direction that the American attack is likely to be most successful, and that what has already been done to some extent in American steel works will be extended in the slips and shops of the ship yard; in fact, a beginning has already been made. Certainly cheap labour will not save the situation for Great Britain, once mechanical ingenuity is brought to bear. The American ship-builder will have the advantage of a more sensible and teachable class of work-people, who are tolerant of new appliances and do not blindly

oppose changes because they seem at first glance to be against the interest of labour. It is but fair to the British ship-builder to say that many suggested improvements and advances have been rendered impossible by labour difficulties, which seem now near an end.

The returns of the United States navigation bureau show that "during the first quarter of the current fiscal year (1898) the capacity of the vessels built and officially numbered was 83,191 tons." This should be compared with 26,805 tons for the corresponding period of last year. These figures are small compared to the enormous British tonnage returns, but they are not insignificant. On the contrary, they are extremely significant if we examine them more closely, for a large percentage of the new tonnage is designed for over-sea traffic, whereas formerly the whole of the American-built ships were intended for the domestic trade. Of late there has been a substantial decline in the construction of steamers for the big lakes. We are told, moreover, that there will be a considerably larger aggregate output of tonnage for ocean trade in the immediate future. A New York paper states that in eight ship-building yards of the United States there are being built (October, 1898) ships which will add to the American merchant-marine one hundred thousand tons. In these yards thirty-six steamers are being built, six for foreign account.

Of course, the figures above given are subject to heavy discount. A good deal of American-built tonnage is still of wood, and a large part of the coasting trade is carried on by sailing vessels. Still, very fine steel steamers are built for the big lakes,—vessels which, either as passenger or cargo carriers, are designed with an intelligence and appreciation of what is needed that is beyond praise; indeed, in freight-carrying appliances the American steamers are, in some respects, as far ahead of European vessels as are the goods-traffic features of the American railways superior to those of the old world.

The ruling-factor, of course, is price, and at present anyone wanting a steamship can buy it cheaper in England or Scotland than in America. How long is that likely to continue? Material, as has been shown, has already been made more cheaply in the United States; labour, on the other hand, is dearer. But the American has a way of doing things and producing things with dear labour more cheaply than others can with cheap labour. That is because he substitutes machinery for muscle, and employs his dear labour where thinking is needed. "Labour is dear, capital is cheap" is his maxim; and so he thinks nothing of borrowing a few thousand dollars—and that at very much higher rates of interest than are paid in England—to spend

upon machinery, if the interest on the borrowed money comes to less than the sum he saves in wages. That is a course open to all, but British manufacturers do not generally look at the matter in this way.

Great Britain is still supreme as a ship-building nation, and, if the ship-builders and steel makers of the country choose to provide in time, there is no reason why she should not continue to hold the first place, with America perhaps a good second. She has a splendid geographical position, placed between the two civilised continents. She has reputation and connection—what auctioneers call "goodwill." She has, moreover, the men,—a population of mechanics and other artificers who have been trained to their trade. I have spoken of the advent of labour-saving methods in the American ship yards. It would, of course, be easy to make too much of this, for the trained man will always be needed, and, the more highly-specialised tools become, the higher must be the training and capacity of those who direct their use, not necessarily those who directly use them. It would be well if British ship-builders could take the initiative by raising the wages of their best men (before the latter go out of the country) and compensate themselves by reducing the demand for labour through improved mechanical devices.

To sum up an article not intended exclusively for ship-builders and experts, Great Britain has lost the advantage she long held in the lesser cost of steel, but she still retains "goodwill" and trained labour, both of the shops, the yard, and the drawing office. America has iron-ore resources which the older country does not possess,—much of her open-hearth basic steel is made from ores almost of bessemer quality,—but, if England makes intelligent use of the good things nature has put within her reach, much can be done to neutralize the advantages possessed by her rivals, in regard to raw material, and bring her nearer to an equality. She will never get back her sometime supremacy—to that great past of "Britain first, the rest nowhere." Other nations are catching up fast, and it is about time she woke up to the fact that, unless she struggles hard for her own, she will drop even to an inferior place among the manufacturing countries of the world.

Since this article was prepared, prices of steel plates, etc., have risen largely, both in Great Britain and the United States. The conclusions, however, still hold good, for what has occurred may occur again. Whether the present "boom" in the iron and steel trade will delay or expedite American shipbuilding development, remains to be seen.

AMERICA AND GERMANY AS EXPORT COMPETITORS AND CUSTOMERS.

By Louis J. Magee.

III. SUGGESTIONS FROM GERMAN COMMERCIAL AND INDUSTRIAL METHODS.

GERMANY'S, and especially Prussia's, greatness is usually attributed to the mighty military organization under which each man is a machine and all spontaneity and individuality are crushed out. This reason, however, cannot account for a vast commerce and industry, nor could the industry have attained to such dimensions if militarism and bureaucracy were as important elements in the character of the nation as they are frequently said to be. The Germans were merchants before they were soldiers, and, despite their splendid army to-day, one does not get the impression in their offices or their factories that they are bereft of liberty, down-trodden by imperialism, or turned into machines by the army. The army, on the contrary, is considered by those best informed to have a beneficial effect—physically, morally, and intellectually. The officers are frequently very hard workers, and those of them who leave the army after years of service to enter the industries bring with them, not only system and discipline, but often a fine capacity for hard work, and not a little technical knowledge. The young engineer who, by reason of his education, has to serve only one year in the army, always profits by the experience, and his career is not disturbed by it.

The personal contact which German and English firms maintain with their customers abroad has been recognised as a great element of their success. The exporting firm should follow up in detail and with deep interest the efforts of its travelling members. The manager at home should know fully what his agent has to compete with, and then try to adapt himself to the conditions. He should keep his agent supplied with ammunition. The agent's complaints should be studied almost prayerfully.

The Germans ought to be the most experienced exporters in the world. They began their foreign trade with the great trade guild which the North German cities founded some six hundred and fifty years ago for mutual protection against not only the pirates and wreckers of the North sea, but also the robber barons of their own land. Long before that, even, the "People of the Emperor" were ac-

corded in English ports equal rights with the English, and the commerce of England was in their hands. It is probable that the coin which they struck in England, the money of the "Easterlings," gave its name to the pound sterling. The staid old firms of the remaining Hansa free cities—Hamburg, Bremen, and Lubeck—have kept up trade traditions from a time when, at the very dawn of international commerce in Europe, the merchant accompanied his own wares by sea and land. Now they gather for redistribution, in their magnificent free-port warehouses, the products of all the world. A younger member of the firm spends a few years in Para, or Valparaiso, or Shanghai. He learns the language, the people, and the difficulties. He returns and settles down to Hamburg home life again, but he continues to "feel with" the colonial part of the firm. The result is that his house does not write exasperating letters, pack badly, or make terms of payment foreign to all the ideas of the customers. The rest of Germany, however, cannot be compared with the Hansa cities in knowledge of export methods. The Hansa people are English in the matter of feeling and filling the wants of a distant clientele. The little town of Remscheid (which town, by the way, had the third trolley road in Europe) and the town of Solingen are surprisingly international. It seems strange to find that their manufacturers have been to Mexico, Australia, or Africa to sell their tool steel, skates, files, and cutlery. One hears with equal surprise the Spanish language on the lips of yellow-bearded Teutons in Barmen-Elberfeld.

If an impartial observer were to study the export trade of the world as it is now developing, and then frame only two maxims, I think he would say: first, manufacture well and cheaply; second, learn foreign languages. None of us can tell when we are going to need to use a foreign language. It is like a revolver; when you want it, you want it badly. I do not mean exactly that we should all learn Dutch, or Finnish, or Russian; but, when the Russian addresses you in good French or German, it is simply disheartening to have to gesticulate, and blush and curse your years of Greek and Latin and your early training, and ask him if he speaks English, and explain that you never happened to learn French or German; that you had read a good deal, but forgotten it, etc. Why, even if you don't go into the export trade, you may be ambassador some day. Our languages we learn like the maps at school; we can name all the rivers, capitals, and capes, and "bound" everything; then, when we sail up the Elbe, we haven't the faintest idea as to whether it rises in the

Alps or the Apennines. The actual speaking and writing of French, German, and Spanish should become an acceptedly natural part of our popular education. Instead of being the speciality of fortunate sons and daughters whose parents live a part of the time in Europe or have the means to employ foreign-born governesses, these languages should be put within the reach of every mechanic's son from the time he enters our splendid public schools. The Germans teach their youngest gymnasial students, if they are taking the classics, to speak Latin. An American friend, who had spent some seven years on Latin at home and then taught it for five years, continuing his studies at Jena, was disheartened to find 12-year-old boys saying Latin sentences which he could scarcely follow. If German teachers can accomplish such things in a dead tongue, Americans ought to be able to do it with a live one. I know many Germans who have never been out of their own country, but who have obtained a good speaking knowledge of French and English in the common schools. A continent lies to the south of the great western republic with whose future the people of the United States may be closely connected. Spanish is exceedingly easy to learn. Why should not all learn it? And even if one never travels, how much that is valuable in foreign literature would be opened to one who reads other languages with ease.

In the every-day work of the large German offices and factories the American notices many departures from his own methods. In general, the strict order and organization evident everywhere in German life characterize the conduct of large concerns. A great many offices work with an intensity equal to that for which Americans, as a nation, are so famous; but results are not so soon evident as they are in the United States, because the public demands voluminous information—including drawings, descriptions, guarantees, weights, and dimensions—before definitely placing an order. Engineering works are usually planned in the central office, so that a minimum of detail is left to the individual judgment of the engineer locally in charge. The commercial side is carefully looked after. The carrying out of engineering enterprises is, as a rule, preceded by an estimate of earning capacity based on running costs, depreciation, interest, amortization, and a conservative rating of income. The engineering firms have not infrequently to take very heavy guarantees for running costs. It is customary to have, for registering, beside the ordinary copy-books, portfolios into which are fastened, in order of time, all incoming or out-going (in copy) communications regarding any enter-

prise, so that one leaves a complete history of the case for one's successor. A great deal is put into writing which we perhaps settle verbally,—a characteristic which has its advantages as well as its disadvantages. Bureaucratic methods have so long flourished that they are justly feared, and are not allowed to have too much sway, in the modern German office. All letters are signed by the management or its legally-appointed representatives. Labor-saving office devices are eagerly sought, and the typewriter is thoroughly introduced. It is somewhat remarkable that the Germans, with their great love of system, should have made hardly any use whatever of card catalogues and the decimal system of classification. There are very few office buildings in Germany designed as such; there are no high buildings and very few elevators.

Although there is an ever-growing tendency in all countries to patronize home industries, the complexity of our modern requirements seems to work in the direction of a general interchange of products. The demand for specialities of a high quality will, in the end, overrun political boundaries. The question as to where an article has reached its highest development and lowest price plays a part of more practical importance wih the purchaser than his theoretical desire to help home industries. The French and Austrian governments put conditions of home manufacture in most franchises, thus seriously interfering with importation. The Germans are intensely patriotic, but they know how to appreciate a good thing when it is offered to them, no matter where it comes from. They may purchase, for instance, the best machine in the world from America, so that they may manufacture with it some other type of machine which shall be the best in the world and be eventually exported to America.

My observations do not confirm a somewhat prevalent idea that the Germans are more given, in proportion to the greatness of their industry, to copying designs of machinery than are other nations. When they do build upon the experience of a foreign firm, they usually pay, directly or indirectly, and desire to make a fair bargain for what they can learn from their neighbor. The manufacturing of any American speciality in Europe does not necessarily put an end to its export by the home factory. Friendly relations with the foreign factories have frequently promoted the output of some of the home factories, due to the extensive introduction of the article which the European firm was able to secure by its influence and acquaintance with the market. But, if they do copy, have not others a debt to them for the results of their patient research in so many scientific

departments,—results which they have liberally placed at public disposal in their laboratories, clinics, and lecture-rooms? Have they not done a great deal of the tedious fundamental work on which we were quick to build? The line of evolution of any of our modern machines, from its inception up to date, would, if followed, lead through other countries than that of the inventor whose name it bears. Inventiveness seems to be more a generally-distributed national characteristic of the American, but a few individual Germans have had enough of it to make up for the rest of their countrymen, and then along with it all, is their colossal patience.

German engineers have usually a thorough theoretical training, including at least a year in some workshop as volunteers. Besides their training in the institutes of technology, engineers entering the government service have to pass severe examinations, work practically under experienced government engineers, and work out some special project, before they receive the title of "Baumeister." In the government service they are engaged chiefly as mechanical engineers, railway engineers, or building constructors. Naturally the ranks of the industry are largely recruited by government engineers who have left the chances of slow promotion, the slender salary, and the pension offered with the service.

The splendid achievements of German engineers in general are too well known to the world to need any praise, and an attempt at comparison with those of other lands would not be of value. A prominent technical educator told me that, to his regret, they were too often unpractical. The German youth, generally speaking, seem to be less inclined to play with tools and to "experiment" than our boys. They do not seem to have from the start such a love for machinery. It is perhaps not unfair to say that the German engineer suffers often from the quality of the lower "personnel" that he has to work with. The average German workman certainly has not as much ambition, energy, or quick perception as one would think from seeing the results of his work. He frequently rebels at the use of machines which displace manual labor, and seldom betters the instruments with which he has to work. He does not seem to get all the work out of a machine which it is capable of doing. These are weaknesses which may not, however, lie in the man himself as much as in his surroundings. German workmen who have spent a few years in America return to the fatherland with great energy and little patience with the slow ways of their fellow-workmen. German carpenters, cabinet-makers, plumbers, and mechanics in general have the

most clumsy and primitive tools—i. e., if they are working outside of factory organization. They do not lay out their work with regard to time, and rarely finish it at the time promised. Despite his heritage from the unsocialistic age of Veit Stoss, Peter Vischer, and Adam Krafft, the German artisan has to-day a poor eye for symmetry and a suprising lack of dexterity and cleverness. Of course modern factory methods are improving the workmen. Medium-size mechanical productions (not the so-called "small wares"), which require compactness of design, gracefulness of form, and refinement of external finish, combined with lightness and strength, seem to be a line in which Germans, for the present, have most improvement to make in the competition for the world's market. The typewriter, bicycle, and sewing machine exemplify this class; also, with some marked exceptions, household utensils, builder's and cabinet-maker's hardware, locks and screws, small tools, etc. These are clumsy, unpractical, roughly finished, and dear at that. Eminent exceptions, for instance, are the beautiful work in their army rifles, physical and chemical apparatus, measuring instruments, cutlery, etc., which show that the above-mentioned branches, in which they are not so strong, have simply been neglected. Of late many splendidly equipped factories have been built, and many of the older factories have purchased modern machine tools, so that a vast development of the industry, along lines which were faulty, is certainly in progress.

On the other hand, there are some departments which the Germans have pursued with such skill and energy as to give them an exceptionally high position,—for instance, in steam engines, boilers, electrical machinery, storage batteries, underground cables, chemical processes, and throughout their magnificent iron and steel industry. The electro-technical industry is especially well developed, as befits the country of its birth. One of the principal electro-technical firms in Berlin looks back upon fifty-two years of electrical manufacturing; another large electro-technical firm boasts of 12,000 employees in its factories, offices, and works abroad. This industry is supported, even in a more marked degree perhaps than any of the other industries, by the great financial groups. Most of the electric plant installed in Europe is made in Germany. Germany exports a great deal also to South and Central America and to the east. German firms are building practically all the large lighting and traction plants in South America to-day.

The gas motor is a noteworthy German specialty; it has been of the greatest service to Germany's "small" industry, one firm alone

having turned out in the last three years 3,196 gas motors for more than 23,000 h. p., and this output is about equalled by at least one other of the numerous factories. Generator gas plants are becoming common, especially for small electric light stations. As an instance of the economy of this system, I will cite the running costs of a small electric station near Hanover; the total coal consumption, including firing up and banking, in a week's test of 69 hours, with an average output of 48.7 h. p., averaged 1.83 pounds per effective h. p. hour. When one remembers that the largest and best steam plants return in work only about 12 per cent., and machines driven by illuminating gas as high as 26 per cent. of the available heat of coal, the revolution that further developments in this line can bring about seems worth working for.

The recent development of generator gas plants for larger powers* and the amenities of electric distribution have combined to make feasible the direct application of blast-furnace gases for power supply. Experiments have been made on a small scale in several works, but the Horder Verein, with a yearly production of 320,000 tons of iron, has taken the question up earnestly. It is now installing a combined gas and electric plant with four 600-h. p. gas motors. These will drive dynamos direct, and furnish power to the steel works and rolling mills three kilometers distant from the furnaces. The first motor was started in the summer of 1898, and indicated 620 h. p. with a gas containing 950 heat units per cubic meter. Even with all the gas available for this purpose, steam plants will have to be retained by the Horder works, especially for the large machines; but the displacement of smaller steam engines by a large number of electric motors would mean a very great economy, even for the 3,750 h.p. which it is proposed to produce eventually with blast-furnace gas.

These are only instances taken at random; anything like an analysis of the German industry is far beyond the intentions of these articles. Despite all that has been, or might be, written of Germany's modern bee-hive activity, immense practical achievement, and far-sighted preparation for the future, many American readers will doubtless still continue to think of the kaiser's realm as an "effete monarchy," with a gaudy throne, many beautiful castles, and a mediaevally sleepy people over-fond of beer. The newspapers, by neglect, ignorance, or distortion of the facts, have allowed the great clever western world to remain under such an impression.

*There are two German gas engines of 200 h.p. each, and one of 160 h.p., running successfully in Switzerland, and engines of 70 to 100 h. p. are frequently met with.

THE INTERNATIONAL ASSOCIATION FOR TESTING MATERIALS.

By Gus C. Henning.

AS early as 1872 a strong desire was felt among engineers in the United States to obtain more accurate knowledge of the properties of materials, because it had become apparent to many that the constants given in books of reference had been found unreliable, and, since new materials were coming into general use, also inadequate. This strong desire found its culmination in a petition to Congress and the Government which caused the appointment of the so-called "Commission to Test Iron and Steel and Other Metals,"* which, after having had the famous "Emery" machine at Watertown Arsenal constructed, and doing some valuable, but disconnected, work, was dissolved by Congress on June 30, 1879. The essential object of this commission was to determine engineering constants, but its members did not recognize the importance of accurate and reliable methods of doing this work. Had such been adopted, it would have been possible, with the amount of money spent, to have laid a foundation for further prosecution of the work by individuals.

In other quarters, however,—notably in Germany,—it had at that time been recognized by Bauschinger and others that it was of the first importance to develop methods which would always produce reliable and comparable results.

It is hardly necessary at this day to furnish proofs that tests of the resistance of materials can be compared only when made according to a uniform standard method.

Even the standard rules for furnishing and testing Portland cements, which were established by the association of German cement manufacturers as long ago as 1876, resulted from the perception that such agreement was necessary. So did the specifications for furnishing axles, tires, and rails of bessemer metal and steel, proposed in 1879 by the general convention of the Association of Railway Managers of Germany, which advised their adoption by the managers of the railways.† But these first steps to establish

* Trans. A. S M. E., II, p. 86, et seq.

† The Properties of Iron and Steel," VIII. Supplementary volume of the publications of the Progress of Railway Construction, Wiesbaden, 1880.

standard methods of testing emanated from quarters which, from their nature, included only technical specialists, on the one hand,—purely manufacturers,—and, on the other, purely consumers; and although, in establishing these standards or norms, there was an endeavor to avoid prejudice, particular interests predominated, and this was urged against the standards on behalf of the opposite party.

Moreover, these deliberations related to one group of materials alone and were not confined entirely to methods of testing, also establishing requirements which these materials must fulfil when tested by the prescribed methods. For this reason it was certainly appropriate for professional men of the most varied technical callings to assemble at Munich, in 1894, at the call of the late Prof. J. Bauschinger, to attempt to formulate uniform methods of testing for the more important materials of construction.

The work of this Munich conference of 1884 coming to the notice of American engineers, notably Dr. Thomas Egleston, of the School of Mines, Columbia College, the latter brought it to the attention of the American Society of Mechanical Engineers at the annual meeting in November, 1884, and the result was the immediate appointment by the society of a "Committee on Uniform Standards in Methods of Testing Materials and of Test Specimens."* This committee first investigated the actual state of the art of testing materials in the United States by studying the methods pursued, and also had many duplicate tests of identical material made by all laboratories and engineers that could be induced to co-operate. The results were so incongruous, however, and the figures obtained were so variable and unreliable, that it was soon found that other methods would have to be adopted.†

In Europe, meantime, a number of important questions were agreed upon; certain others were referred to a standing committee, which considered them primarily by letter, and discussed them orally,‡ later, at two meetings held at Munich, September 21 and 22, 1885; and, finally, the results and conclusions were presented at the second general conference, held at Dresden, September 20 and 21, 1886. The latter concurred in most of the conclusions presented; but there remained a number of unsolved problems, which were intrusted to a second standing committee, whose duty it was to dis-

* Trans. A. S. M. E., Vol. VI., p. 350.

† Ibi ., Vol. XI., p. 603, *et seq.*.

‡ The detailed report giving the transactions of the conference at Munich, and the constitution of its standing committee, are contained in the fifteenth part of "Mittheilungen aus dem mechanisch-technischen Laboratorium der technischen Hochschule München." Munich. Theo. Ackermann.

cuss them, and then present the findings to a third conference which met at Berlin, September 19 and 20, 1890, and at which a part of the problems were solved. The others, with new ones suggested by further study, were again returned to the standing committee, which was to report thereon at the fourth conference, to meet at Vienna. This last conference met on May 24 and 25, 1893, but again only a portion of the problems were considered solved, the others, besides additional new ones, being turned over to a fourth standing committee for further study. It was also decided that the chairman of this committee be authorized to issue a corrected and complete memorial, containing all the resolutions of the several conferences, similar to that issued in 1887.

The hope expressed in that memoir—that it "might keep alive the interest in the work of the conference, and might create it in such quarters as had kept out of touch with them"—has been fully realized.

Not only was the number of representatives from countries already interested (Germany, Austria-Hungary, Switzerland, and Russia) considerably augmented, but other countries (France, the United States, Norway, Holland, Italy, Belgium, and Spain) sent engineers; so that the conferences assumed a truly international character.

To further the growth of these conferences it was deemed necessary to state that each was a voluntary convention of men assembled for a free exchange of opinions upon the best methods or systems of testing particular materials which are to serve definite purposes. If resolutions are adopted at such conferences, they can decide only which method of procedure is considered the best by the majority of those present.

According to the first resolution of the first conference, "the discussions are to be free, and the resolutions not binding." There are no obstacles to reconsideration of a question decided by a previous conference. Methods of testing cannot remain the same; they must be developed in accordance with our increasing knowledge of the properties of materials used in construction, with the improvements made in their production, with the adoption of new materials for the same, etc.

It, therefore, becomes necessary that those who take interest in testing materials, from a scientific standpoint, or because they are manufacturers or consumers, shall assemble from time to time, in order to deliberate afresh, exchange opinions, and mutually learn

and teach; and then, as a result of their deliberations, agree upon methods of testing which are by them, or at least by the majority, considered the most satisfactory for the time being.

The close relations existing between all civilized industrial countries, generated by constant intercommunication, would make the resolutions of such conferences of little value, if they were the expression of opinions of engineers in a few countries only. Hence the necessity that they should be international in character made itself felt, and led to their internationl development, though they were limited originally to Germany and a few neighboring States.

On the basis of these Resolutions of Conferences and the tests made for the committee of the American Society of mechanical Engineers, its committee prepared a report* and presented a translation of the Resolutions of Conferences,† and since that time it has kept in close touch with the work of the conferences.

By a presidential decree in France, dated November 9, 1891, a "Commission des methodes d'essai des materiaux de constructions" was created, having the same object as that pursued and developed by the Conferences of Munich, Dresden, Berlin, and Vienna, and their standing committees. Unquestionably official establishments of this nature have two distinct advantages over voluntary conferences: (1) they have greater authority, at least in their own country; (2) they control funds for extended series of special investigations, which may become necessary. They, however, have not an international character, which must be secured by some relation between the different governmental commissions, and they certainly have not those qualities, emphasized above, which are characteristic of voluntary conferences. The advantages of the latter, however, could still be enjoyed if the standing committees, working during the intervals between such conferences, were composed of voluntary industrial representatives, as well as delegates, of technical departments, authorities, societies, etc.

This French commission took part at the conferences of Zurich, in 1895, and Stockholm, in 1897. Although some of the problems proposed were solved in each interval, others sprang up to take their places, so that at the present time there are about twenty-one still unsolved. After the definite solution of some of the original abstract problems, those of a more distinctly practical character were taken up, so that at present the preparation of standard specifica-

* See Trans. A. S. M. E., Vol. XI., p. 604.

† Ibid., p. 527, also Vol. XIV., p. 125.

tions for properties, and inspection of materials, are among the more prominent.

At the conferences of Vienna and Zurich it became apparent that generally valuable results could be obtained only by international co-operation, which idea was finally adopted at the Zurich conference, and was carried into effect at the Stockholm conference, which became the first meeting of the International Association for Testing Materials. This produced an immediate accretion to the memberships, so that it seemed desirable, for the purpose of ready co-operation, to divide the association into national sections; consequently the memberships united themselves into auxiliary bodies, each being represented on the central council, whose seat is at Zurich.

In August, 1898, the American section of the International Association for Testing Materials was organized by selecting Prof. Mansfield Merriman, of Lehigh University, as president, and Mr. Richard L. Humphrey, in charge of the City Testing Laboratory, Philadelphia, as secretary.

Among the more important problems which are now before the Association, and which have been submitted to the various sub-committees for investigation, are those explained below. These sub-committees are international in character, each national section naming its representatives, selected from its membership according to their respective qualifications. As membership in the association and in these sub-committees is entirely voluntary, it is hoped that only such co-operation will be secured as is most likely to lead to satisfactory practical results.

The membership is composed of directors of testing laboratories, professors at schools of technology, engineers, railway officials, architects, foresters, and, last but not least, manufacturers of materials of all kinds. In addition to individuals, many organizations and governmental departments have voluntarily assumed membership, and military and naval officers of nearly all countries are regularly detailed to attend the deliberative sessions, and report the results of proceedings to their respective governments. The United States were represented at Zurich by an engineer officer, and at Stockholm by an officer from each of the engineer bureaus of the departments of the army and navy.

The International Association now has a membership of more than sixteen hundred, and of these more than one hundred are resident in the United States, forming the American section. The

growth of this section is rapid, and, if the manufacturers take as much interest in the objects of the association as now seems probable, it will become a very important body.

The primary object of the association is laid down in the second section of its statutes, as follows:

"The objects of the association are the development and unification of standard methods of tests for the determination of those qualities of materials of construction and others, which are of technological importance, and the perfection of apparatus used for that purpose."

This paragraph, in its broad interpretation, pre-supposes a complete study of all materials used by the engineer and artisan, not only as to methods of testing them, but also as to their properties. A study of methods of testing makes it imperative to learn the properties of materials, because a difference in method may, with materials of different properties, produce different results. Hence, while certain methods answer to obtain accurate knowledge of properties of some materials, they fail with others. This comparison of methods in their effects on tests of materials of different properties necessarily produces grouping of materials into classes. Therefore, the question of constituting characteristic classes of materials follows as a natural consequence; moreover, the ready identification of material with a particular group is closely connected with it. Hence the objects of the association must include, besides those directly stated in its statutes, the very practical subjects of specifications and inspection. In view of this explanation of the objects of the association, various new problems were proposed at the Stockholm congress, which are to be studied during the interim, and reported upon at the next congress, to be held at Paris during the international exposition.

The problems are divided into three groups,—viz.:

I. Metals.

II. Natural and Artificial Stone and Their Bond Materials.

III. Other Materials.

These groups are presented and discussed at the congress, at the same time, in three sections, arranging themselves according to the preferences of individual members. The resolutions adopted by each section are then referred to the entire association in plenary session, and acted upon.

Under Group I. the following problems are now in course of study:

(1) Establishment of international standard methods of testing and inspecting iron and steel, based on specifications in actual use.

(2) Establishment of methods of determining uniformity of iron and steel, applicable for purposes of inspection.

(3) Study of the behavior of wrought iron at abnormally low temperatures.

(4) Study of investigation of welds and weldability.

(5) Collection of information as data for the establishment of standard methods for piece-tests, with special reference to axles, tires, springs, and cast and wrought-iron pipes, as well as parts of iron and steel construction.

(6) Study of the most appropriate method of polishing and etching for microscopic examination of the structure of wrought iron.

The problems of this group, especially Nos. 1 and 2, have appealed most strongly to the American section, which therefore has appointed special committees to study the subjects from a strictly practical point of view. This work is to be done independently of the international commission, by men closely connected with some of the largest American steel works, such as the Carnegie and Pennsylvania Steel Companies.

The problems of Group II. are as follows:

(7) Determination of the relation between chemical composition and weathering qualities of natural building stone. (a) Determination of the effect of gases of combustion, especially sulphurous acid. (b) Determination of methods of testing properties of slates, especially their weathering qualities.

(8) Determination of rapid methods of testing conditions of constancy of volume of hydraulic bond materials.

(9) How can the strength of hydraulic bond materials be determined rapidly?

(10) Testing the resolutions of conferences relating to the determination of adhesion of hydraulic bond materials.

(11) Preparation of uniform methods of testing puzzuolanas as to their value in mortars.

(12) Investigation of causes of abnormal setting of cements.

(13) Determination of conditions which will produce approximate equality of density of test briquettes and cubes for tension and crushing tests of cement.

(14) Determination of effect of sulphurous acid on artificial building stone, and on mortars.

(15) Study of the effect of sulphurous acid, in aqueous solution and in gaseous form, on mortars.

(16) Study of effect of sewage on the strength of hydraulic bond materials.

This group of problems clearly indicates how much really remains to be done in the way of determining the properties of mortars and cements before it can be stated whether certain brands are suitable for certain purposes. In a country like the United States, where the cement industry is comparatively new, these subjects are of especial importance; for if the methods of testing or determining their qualities are not even fixed, how can we be certain that the materials themselves are satisfactory? As a rule, tests of cements and mortars must extend over long periods of time before definite information can be obtained; hence the work of this group must extend over a number of years.

Group III. covers a wide field of materials used in all the arts and trades; whether tile or paper, silk or glue, glass or paint, everything is produced to obtain certain results, and sold under guaranties.

With this in mind, reliable methods of demonstrating that such materials fulfil the guarantees. seem an absolute necessity; hence much attention is paid to them. Paper, for instance, is as carefully tested and inspected as iron and steel are; leather is generally tested with equal care; and the necessity of controlling the paint contractor need hardly be mentioned. Hence the following problems will be studied:

(17) Unification of methods of testing tile pipe.

(18) Establishing uniform methods of testing preservatives of iron structures against corrosion.

(19) Determination of bases for uniform methods of testing lubricating oils.

(20) How can ultimate appearance of dry rot (merulius lacrymans) be guarded against, while inspecting timber.

The eminently practical character of the work of the association is again shown by the last three problems. Any one who has had experience with dealers in lubricating oil and paint will readily recall the many infallible tests applied by each to prove the absolute worthlessness of the "other fellow's stuff," and the disappointment, expense, and accidents caused by the use of poor material—conscientiously applied, it may be— through lack of reliable methods of testing.

If the problems in Group I. and III. should be gradually solved by the Association, it would deserve the lasting thanks of manufac-

turers and engineers alike. The work is not like that of engineering societies, which are composed of non-homogeneous aggregations of specialists, publishers, and supply-dealers, too conservative to condemn or approve openly. The work of this association is mainly to establish bases for such condemnation or approval, applied by each individual for himself, according to his needs or condition. It does not deal with shades or grades of specialties, but with complete groups of material as such, with reference, not to their provenance, but mainly to their applicability and reliability.

It is not sought to make distinctions of any kind that may lead to antagonism or preference, as the association deals mainly with the abstract properties of material, not with the solution of engineering problems, more or less important locally.

Its relations are rather with trade than with abstract problems, for it helps to mutual understanding, among distant nations, of the qualities and sources of materials.

A complete and exhaustive demonstration to this association of the superior quality of American materials must certainly assist greatly in bringing about their general use in foreign countries, and for this reason it is hoped that American engineers and manufacurers will assist to the best of their abilities in the solution of the problems of the International Association for Testing Materials.

EDITORIAL COMMENT

As the monthly record of engineering progress, collected in the form of titles and abstracts in The Engineering Index, is examined as a whole, it is possible to see that the various departments of engineering are in so great measure dependent upon each other that any clearly defined division into departments and sections is impossible. The work of the civil engineer overlaps that of the architect on one side and of the mechanical engineer on the other, while electrical and mechanical engineering have become so closely connected as almost to be merged the one into the other.

An excellent example of this connection is seen in the revival of interest in masonry construction on the part of the civil engineer, with especial relation to the construction of masonry arches, while at the same time the mechanical engineer is meeting the weak point of masonry, i. e., its inability to resist tension, by the wholly *un*-civil method of imbedding structural-steel members in the mass of mason work. The marked interest in the subject of reenforced concrete, whether called by the name of Monier, Melan, Hennébique, or whoever else, is shown in numerous articles, all of which indicate the genuine interest of the practical constructor.

Closely allied to the interest in concrete construction are the papers relating to improvements in the manufacture of cement, showing the efforts which are being made by manufacturers in response to the demand for a product of continually higher grade.

A kindred branch of industry is that of effective methods of fire proofing, in which the interest aroused by recent disastrous fires, still continues keen and unabated.

* * *

The cessation of hostilities, so far as Spain and the United States are concerned, has had the natural effect of diminishing the number of articles upon purely military matters; but the interest which has previously been directed toward the engineering of destructiveness now appears to be expending itself upon matters of construction, still, however, in the department of fighting machinery. Plans for new battle ships, improved devices for rendering still greater the destructiveness of artillery, or for disabling the weapons of the enemy, are subjects of animated discussion and there is little doubt that engineers and mechanics, in various parts of the world, are all striving to render present methods and equipments antiquated and obsolete as rapidly as possible.

* * *

Another branch of engineering aggressiveness, and one which can be regarded with greater satisfaction, is the good work which is being done by the engineer in the exploitation of undeveloped portions of the globe. The Trans-Siberian railway, reports concerning which appear almost every month, is being pushed forward with determined energy. The bridge work over most of the great rivers is practically done, and the open secret that the true terminus is to be Port Arthur adds to the interest in this great undertaking. To this must be added the report of the commission upon the Inter-Continental railway, which may some day connect the railway systems of North and South America—a work which, however differently it may be regarded in various quarters, appears to be altogether feasible from the standpoint of the engineer.

* * *

The utilisation of natural sources of power continues to attract attention, and in this connection there appears a source of water power which can hardly be called natural, and for which a more appropriate name would be unexpected. The Chicago drainage canal, now nearing completion, is an artificial water way originally intended solely for the purpose of diverting the drainage of Chicago into the watershed of the Mississippi; but it now appears that the head thus developed produces a large amount of hydraulic power which only

needs the erection of a suitable power plant to be made immediately available. That this will be done there is no doubt, and, with the aid of electrical transmission, the energy of the canal will be delivered to Chicago or elsewhere.

* * *

As noted last month, the close connection of the engineer to the protection of public health continues to be the theme of many articles. It is becoming more and more evident that such a thing as a source of pure water, in quantity available for the enormous supply demanded by great cities, must not be expected; for such sources, even when found, cannot be controlled. For this reason the work of the physician, the bacteriologist, and above all, of the engineer must be directed toward the development of the best methods of rendering sewage harmless, before it is discharged into any stream which may afterwards be drawn upon as a source of water supply, as well as toward the provision of filtration methods and appliances for the purification of the water supply itself.

That this can be done is now a matter of scientific certainty, and in the accomplishment of this most important work the engineer has done his full share.

* * *

In the increasing domain of the applications of electricity there are no absolutely new features to be noted, but there are many positive indications that older methods of power transmission must rapidly give way to the electric current. In the machine works both belting and shafting will soon become obsolete, and every month evidence of this transformation appears, while even on that most conservative of all places, the farm, we hear of electric ploughing, threshing, and even sheep-shearing. Electric traction continues to absorb its full share of space allotted in the columns of the Index, and indications are not lacking of the application of electric power to main-line railways.

Within the especial domain of the mechanical engineer there has been quietly developing for several years past a transformation in practice and methods which is only gradually being indicated by the articles on tools and methods which appear from time to time. From being a place where everything can be made in any sort of a way, the machine shop is becoming a place where very definite products are made in a most systematic manner. Specialisation is the order of the day, in products, operations, tools, and men, and the works which attempts to continue along the old lines may soon find that there are no old lines to follow, that which was merely old having suddenly became obsolete. Articles upon works, organisation, factory accounting, the design of special machinery, the use of special tools—these and many others are but surface straws upon a quiet but powerful current which is cutting a new channel that may leave many of the old landmarks on one side.

* * *

Public works form the subjects of numerous papers of interest, especially in the United States. The isthmian canal still remains unsettled as to location, and the rival claims of Panama and Nicaragua must undergo the ordeal of critical investigation under the action of Congress. It is to be hoped that the impartial investigation of the engineer will be permitted to guide in a matter of such world-wide importance, and that it may be wholly removed from the domain of politics under which it has so long languished.

The necessity for the construction of important dry-docks in the United States has led prominent engineers, both in and out of the government service, to protest against the building of any more timber docks, and the effective manner in which the superior economy of masonry construction has been set forth should prove an effective answer to any claims made for the timber docks on that score. The penny wise pound foolish policy certainly should not be permitted to prevail in a case where the true interests of the service are so clearly apparent.

* * *

Electric lighting continues to make progress, and that, too, along lines where it was least expected. For some time there has been much effort and ability directed toward the improvement of the arc lamp, with the result of the production of the enclosed arc and other minor features; but the allied field of incandescent lighting has until very recently shown little or no ad-

vance. The advent of an unenclosed incandescent lamp of long life, high efficiency, and great flexibility marks an epoch in electric lighting, and the invention of Professor Nernst, reviewed elsewhere at length, forms the subject of one of the notable papers of the month. From Germany also comes another invention in the domain of electricity in the form of a remarkable current-interrupter, utilising a hitherto unappreciated fact in electrolysis, and this invention of Professor Wehnelt bids fair to effect a great increase in the capacity of induction coils, and in the generation of currents available for advanced researches in radiography.

Altogether the month has been a busy one, both for the investigators and the recorders, and in the columns of the Engineering Index may be found the record of the records, for those who wish to follow the progress of the profession as a whole.

* * *

The Pratt & Whitney Co. have addressed to Mr. Norris and to the Magazine a further explanation of their method of valuing standard drawings, which quite removes any ground for the implied criticism expressed by Mr. Norris on page 817 of our February issue. To the question "How do you value your standard drawings?" their reply was "At cost some years ago, and have, since this item of cost was established, let it remain at the same figure, with year additions of not less than $12,000 to $15,000." Interpreting this to mean that $12,000 to $15,000 was added yearly to the original cost valuation of the drawings, in making the inventory, Mr. Norris criticised vigorously any policy which classed as "pure, unshrinkable capital" a class of equipment so clearly a "means to an end,—a necessary evil in production" as are standard drawings.

The meaning which the answer was intended to bear, however, is that, while drawings costing $12,000 to $15,000 are added each year, the total valuation is nevertheless kept at the original figure fixed several years ago, without any addition to the inventory for these large yearly expenditures. They are practically assumed merely to offset the depreciation of the existing equipment. Granting, as Mr. Norris does, the propriety of considering standard drawings an asset, this is providing a very safe factor of depreciation.

In the light of the explanation, the original statement is quite clear. Probably, however, most of our readers have interpreted it as Mr. Norris did, and we are happy to correct an unfortunate misconception and to withdraw, for Mr. Norris, a criticism which is evidently unmerited so far as the Pratt & Whitney Co. is concerned.

* * *

The movement toward trust-forming in the United States—long since unreasonable—is taking on a rate which threatens to be uncontrollable and to end in plunging the country to a financial and industrial crash.

It is a curious, and apparently contagious mania which has seized the American manufacturer. The great wit of his economy has passed into madness. Granting that much may be said in favor of singleness of management, of the economy of manufacturing on a vast scale—of the elimination of useless duplication of plant and of managers—the cases where the arguments apply are few and, even in these, the application is usually limited.

The trust will succeed and persist only so far as it aids in cheapening production and distribution and, by reasonable sharing of the benefit, increases consumption proportionately. This is the natural evolution of manufacture and trade, and, as the firm has sometimes advantage over the individual, and the corporation over the firm, still larger consolidations may be "indicated," as the doctors say, in certain cases.

But a mere agglomeration of manufacturing units effecting no important savings in processes or in direction, and stimulated only by the hope of unusual profit through stifling of competition and an artificial control of the market, is economically immoral and a menace to the community and the nation.

Of this sort are many of the recently announced American "trusts"—weeds of an overstimulated financial soil and the artificial atmosphere of a high tariff. There seems to be no course to follow but that of the Master of the wheat and the tares: "Let both grow together until the har-

vest;" out of the threshings and chaff-burnings of an industrial panic the sound growth of true enterprise will endure, but the fruit of the trust-promoter will be known by the bitterness of its ashes.

* * *

The passage, by the United States Congress, of the Naval Personnel bill is an official recognition of the status of the engineer in a quarter in which the combined force of military and sea traditions seemed almost hopelessly strong against it.

It is far more than a matter of title and shoulder straps—more than the establishment of the plainly necessary right to command, and the removal of the anomalous state which permitted the attempt to put a staff officer under the orders of an enlisted man. It is a reorganisation of the navy in recognition of the fact that the war-ship is a vast engineering establishment—that every movement of the vessel and every exercise of every function is made by mechanical power, and that all her officers must be engineers if the highest efficiency is to be had.

The bill abolishes the old distinction of "line and staff" and merges all in one homogeneous body, the present engineer corps receiving actual rank and title and the line officers becoming engineers, to the extent, at least, of the abolition of a distinct body whose knowledge and duties are confined to the deck and the guns.

In the lower grades, however, provision is made for a good number of "warrant-machinists," similar to the artificer engineers of the British navy, whose functions, like those of boatswains and gunners, will be closely specialised.

The measure seems to be wisely general in its provisions for gradual accommodations of the service to the change. The older men will not be required to change their province; the "middlers" have an option as to continuing their specialisation; the younger men are to be trained up in the new order.

There is nothing to prevent the development of natural aptitude or inclination for particular work, whether it be navigation, ordnance, or the engine-room. In the main, however, the same man will be fully competent to stand watch at the engines, on the bridge, or at the battery.

The result will be enormously beneficial to the service, and cannot fail to have a large influence in the British navy, where a similar measure is sought by the engineers, with small prospect of success.

* * *

It is extremely gratifying to see that sound judgment has asserted itself in a matter so important as the espousal, by the United States, of the American isthmian-canal project. Even up to the time of our last issue the matter was in doubt. The leaning toward a hasty adoption of the Nicaragua route seemed so strong that one hardly dared hope for a patient hearing of the whole case, even though provision for the consideration of "some other route" was carried in the Senate bill.

The House, however, justified our forecast, and the provision made, as a result of their attitude, is as near as the present state of political feeling would permit to the ideal sketched by Mr. Hunter in our March number. It provides, in brief, not for acquisition or construction, but for thorough investigation, appropriating therefor the sum of $1,000,000.

It seems probable, from the reports, that the agreement was reached because the House and Senate conferrees respectively construed it differently—the former as committing the Government to nothing beyond the immediate provision, and the latter as binding the United States, by implication, to the construction of a canal.

The commission of examination will not be international, but it may be considered certain it will be impartial. It is suggested the President may enlarge and continue the Walker board, which has not yet completed its work on the Nicaragua surveys. At all events, the danger of a stampede seems to be passed. With ample funds, sufficient time, and a competent commission of high character and ability, the facts will be made clear. In the interest of the engineering, the maritime, and the commercial world, may the best route win!

THE BRITISH PRESS

Review of Leading Articles

The Study of Alloys.

THE development of the modern methods of studying the chemical and physical characteristics of metallic alloys has been very rapid during the past few years, and since 1891 the work of the Alloys Research Committee of the Institution of Mechanical Engineers has contributed materially to the knowledge of the real reasons for the behaviour of alloys.

The fifth report of the committee, recently presented by Sir W. C. Roberts-Austen, contains much interesting matter, and is devoted to the behaviour and constitution of steel, with particular regard to the conditions which exist during cooling and solidifying.

The real nature of steel is a matter which has been much discussed, and about which much uncertainty yet exists, but the results of the most careful observations seems to indicate that the solution theory, i. e., that the carbon is dissolved in iron, much as salt may be dissolved in water, explains the behaviour better than any other hypothesis.

The best way in which the action of iron and carbon in forming steel can be explained, is by comparison with the phenomena which occur during the freezing of a solution of salt in water.

If a thermometer is placed in a ten per cent. solution of salt in water, and the temperature is gradually lowered, the mercury will cease falling at about 18° F., at which point the separation of pure salt-free ice will take place. The mercury will then continue to fall until at a temperature of —8° F., the so-called entectic, or lowest liquid point, is reached, and the ice and salt solidify together. This solid mass then consists of crystals of ice and of salt merely in contact with each other. As the degree of concentration of salt in the original solution increases, the initial freezing point will be lower and lower, the second freezing point always remaining constant at —8 F., and when the solution contains 23.5 per cent. of salt, both freezing points coincide at —8 F.

If now the solidification of melted steel, or iron with carbon in solution, is considered, the solidifying being practically the freezing of the alloy, a similar action takes place. As the iron solidifies, a portion of the carbon separates out as graphite, while on further solidification a solid solution of iron and carbon is formed, these actions depending upon the percentage of carbon present in the steel, and upon the rate of cooling.

It is impossible to discuss here the various combinations observed with steels and irons of different composition and character, but the admirable illustrations accompanying the original report show how well the characteristic features of the alloys can be detected by the use of the microscope.

By the study of polished and etched sections of rails and other steels under the microscope, it is seen that the metal appears as a rock with various minerals distributed through it, and, since the different kinds of crystals are differently attacked by the etching solutions, their form and distribution can be very clearly brought out.

The effect of rapid cooling, as in the operation of hardening, is especially instructive, the form and character of the constituents varying very materially according to the rapidity and degree of cooling. Some very interesting micro-photographs are shown of specimens heated to a temperature of 1,832° F., and quenched in liquid air at a temperature of —328° F., the physical structure being very clearly brought out.

The practical applications of these highly scientific researches are already being brought out by the study of the structure of steel rails, as compared with their behaviour in actual service, and there is every evidence that the simple operation of polishing and etching properly selected sections, and a microscopical examination, may hereafter be the powerful auxiliary of the chemical laboratory and the testing machine.

The Nernst Lamp.

FOR some time there have been brief notes in the Continental papers about the improved incandescent lamp invented by Professor Nernst, and these have been supplemented by a full paper on the subject, read before the Society of Arts by Mr. James Swinburne.

Before proceeding to the main subject of his paper Mr. Swinburne makes some remarks about incandescent lamps in general, with especial reference to their low efficiency, and to the small progress which has been made in them during the past fifteen years.

"Considering the enormous importance of the incandescent lamp, its improvement has received extraordinary little attention. It limits us as regards pressure, it used to hamper us by its cost, and it limits us very seriously by its inefficiency. Of course mere detail improvement in manufacture has taken place, and this has led to better quality and greater uniformity, hence cheapness; but there has been no radical improvement."

There is, therefore, room for an improved incandescent lamp, and it is in the line of improvement that Nernst has been working.

The principle of the Nernst lamp is simple, as it depends entirely upon the fact that the hotter we can make an incandescent body, the higher its efficiency will be. There is a limit to the temperature at which a carbon filament can be used, since it has a low specific resistance and is also long and slender. Nernst has therefore chosen a material of which the exact composition is not given, but which is composed of highly refractory oxide, presumably of some of the metals of the alkaline earths, using a short rod mounted between platinum wires and supported in a holder. In addition to being highly refractory the material is also of high specific resistance so that it can be made quite strong, and as there is no combustion to take place, there is no need for an enclosing bulb or vacuum.

Since the rod, when cold, is an insulator, the lamp cannot be lighted merely by turning on the current, but requires the use of some external source of heat, such as a match or preferably a spirit lamp to start it. When the rod is warmed the current flows and when thus started the lamp soon attains a high degree of brilliancy. As the heated rod is a electrolytic conductor there is a gradual wasting away, which cannot be checked by enclosing it in a vacuum bulb, but the rods as at present constituted have a life of more than 500 hours and it is expected that this will be greatly extended as experience in their manufacture is gained. When the rod is worn out a new rod with its wire mounts is all that is replaced, and the whole lamp is not thrown away at all.

The principal objection to the Nernst lamp is the necessity of lighting it with a match, so to speak, and the ordinary incandescent lamp has demonstrated so fully the desirability of the self-lighting feature, that the necessity of retaining this point has been felt.

Modifications of a device utilising a heating resistance, which is cut out after the current flows through the rod have been found applicable when automatic ignition is considered necessary, and either with or without such an attachment the invention of Professor Nernst provides a high-efficiency incandescent lamp capable of being operated at high pressures, and furnishing an agreeable and manageable light at moderate cost.

In discussing the possibilities of the system Mr. Swinburne calls attention to the great desirablility of an incandescent lamp for use with high pressures and consequently smaller conductors, while as compared to arc lamps the Nernst lamp will be very much cheaper in first cost and enormously cheaper in maintenance. Large lamps can be made to work in parallel at 500 volts, and by using double rods, at 1,000 volts, thus putting an entirely new development in electric lighting in the hands of the engineer.

In the discussion on Mr. Swinburne's paper attention was called to the fact that in the early Jablochkoff candle there was a strip of kaolin between the two carbons, which became incandescent, and added very materially to the luminous power of the lamp, while in the so-called "Lampe Soleil" an arc was struck across a surface of marble which ultimately became incandescent; but both of these used the refractory material as an auxiliary to an are

between carbons, and both have become obsolete for very obvious reasons.

While the Nernst lamp is hardly yet in the commercial stage it will undoubtedly be given every opportunity to demonstrate its practical utility and value, and at the present time it certainly appears as if an important addition to the application of electricity to illuminating purposes has been made.

Steam Automobiles.

ALTHOUGH the advent of the modern automobile vehicle is largely due to the advances which have been made in the storage of electric energy and in the improvements in internal combustion motors, yet for many reasons steam is still an important and valuable medium for motive power for such vehicles, and with recent improvements in light weight generators and engines it has many claims to consideration, especially in connection with the heavier class of automobiles.

A paper upon the application of steam to self-contained road vehicles was recently read before the Liverpool Traffic Association by Mr. W. Norris, in which the conditions of road driving as affecting steam machinery are discussed, and a number of interesting points emphasised.

In the eyes of many engineers steam has numerous advantages, especially when one may be away from home, or from convenient access to a repair shop or charging station, and when, as is usually the case, liquid fuel is used, a fresh supply may be procured at almost any country shop.

An engine, to be well adapted for motor-vehicle purposes must, of course, be constructed so as to meet, as far as possible, the very exacting requirements. The lightest possible construction must be combined with the greatest possible strength and simplicity, the bearing surfaces must be ample, the rotative speed high, and the valves adapted for the high pressure which must be used. The working parts should be protected from dust, and yet readily accessible when necessary, and careful balancing and smooth and quiet running are most essential. If a high fuel and water economy is expected, it is important that the engine be constructed to run at a constant speed, a system of reduction and change gears being employed for changes in speed.

Equally important with the engine is the boiler, and as light weight must be combined with strength to resist high pressures, and with ample heating surface, much care is required in its design.

The capacity and economy of the boiler will depend very much upon the area of its effective heating surface, and when it is considered that only a portion of the surface is in direct contact with the flame, and that it is practically impossible to transmit a uniform degree of heat to the various portions of the surface, it will be seen that the disposition of the surface is of as much consequence as its extent. In the case of oil fuel the arrangement of the burner with regard to the heating surface is also important, since some of the tubes may be almost ineffective so far as steam generation is concerned, if the flame and hot gases do not reach them properly. The value of a unit of heating surface depends mainly upon the relative position and direction in which the current of heated products obtains contact with the metallic surfaces.

Many of the questions involved in automobile construction are independent of the character of the motive power, and among these one of the most important discussed by Mr. Norris is that of the wheels. Although his remarks are mainly intended to refer to wheels for heavy road vehicles they apply in many points to wheels for automobiles of all kinds.

The great difference between the wheel for a motor vehicle and a waggon which is to be hauled lies in the fact that one drives and the other is driven. In a vehicle which is hauled by horses the wheels act mainly as supports and are pulled forward by a force applied at the centre, while the turning force is applied at the rim. In a motor vehicle, on the contrary it is the turning force which is applied at the hub, tending to twist it around within the spokes, and thus causing a great strain upon the wheel in a manner which is difficult to resist. It has not been found practicable to make a wooden wheel which will stand the wear and tear for any length of time, and although steel wheels of satisfactory strength have been designed yet they are

heavier than wooden wheels if made strong enough for the service. Broad tyres are desirable not only for the protection of the road but also for ease of running and durability of the wheel, so that the best wheel is by no means the handsomest.

Mr. Norris's paper will undoubtedly call attention to the fact that steam is yet and probably will continue to be a strong competitor of the electric accumulator and the petroleum motor for automobile propulsion, and while the ultimate determination of the best source of power has not yet been attained, there is ample reason to believe that steam will maintain an excellent showing for heavy-weight vehicles at least, and possibly for lighter ones.

The Construction of Ocean Steamers.

THE continual increase in size exhibited by the successive productions of the ship builder's art has involved some important modifications in structural features, and as some of these modifications are directly connected with the arrangement of the propelling machinery the two problems of hull construction and machinery are closely allied.

In a recent editorial in *The Engineer* this subject is discussed at length and some points of importance brought out.

As in many other cases, the controlling conditions for small structures become subject to material modifications as the dimensions increase, the changes being due not only to the increase of stresses with increased dimensions but also to the demand for greater proportional space for the engines and boilers.

"A comparison made between the framework of an ordinary tramp and that of an up-to-date trans-Atlantic greyhound will show several marked differences. The newer and better class of tramp has generally a deep and capacious hold, with two steel decks and no more than two tiers of beams. She has the minimum number of transverse water-tight bulkheads required for classification purposes; these ranging in number from four to six. To secure deep and lengthy hold spaces, tiers of beams must be omitted which would otherwise have been fitted, and the necessary transverse strength is supplied by means of deep girder frames, or web frames, in each case associated with strong hold-stringers.

"Within certain limits of size such vessels may be, and are, made thoroughly strong and efficient, as is shown by the excellent way in which they regularly do the work to which they are put. But when these dimensions are exceeded, and the engine power is placed in them necessary for the attainment of great speed, vessels require other and more complex structural arrangements; and when they have further to transport a thousand passengers across the Atlantic at all seasons in the year, with the nearest approach to absolute safety which it is in human power to attain, then still further structural additions have to be provided."

On the passenger steamer more decks and more bulkheads are required than on the tramp, both for structural purposes and also to provide for the increased cabin accommodation, but at the same time the large space demanded in what is practically the weakest portion of the vessel for the machinery interferes very materially with the marine architect's plans. Anyone who has gazed down the great well in which the twin screw engines of a modern liner are placed should realise that all that mass of machinery absolutely precludes the best framing of that portion of the vessel, and makes the problem of compensating for the omission of normal structural arrangements most difficult.

The soundness and efficiency of the great modern liners in actual service demonstrate that these difficult requirements have been successfully met, so that, notwithstanding the conflicting conditions, the modern passenger steamer is amply capable, from a structural point of view, of resisting the heavy stresses to which she may be subjected.

It has sometimes been thought that vibration in a vessel is an indication of structural weakness, but this is often not the case. Vibration is largely a question of synchronism of the beat of the engines with the vibratory period of the hull, and a moderate change in the speed of the engine is often sufficient to destroy the pulsations. The speed at which one vessel vibrates most is that at which another of different form and dimensions is the stead-

iest, and in many cases an increase of engine speed diminishes the vibrations.

There is no product of the work of the engineer more worthy of study and patience than the relation of the motive power of a vessel to the construction of the hull, and while as yet the question of the relation of the period of engine beat to the dimension and shape of hull to produce or avoid vibration can as yet only be determined after construction and remedied by subsequent measures, there is no reason why this should always be the case.

Much has been done to reduce the initial vibration of the engine itself, and the problems of counterbalancing have been solved to a great extent, but the greater problem of the relations of the pulsations of the engines to the vibrations of the hull still invites study and experiment.

Tests of Timber Trusses.

THE influence of precedent and authority in engineering work must of necessity be great, especially in connection with government and official work, where any attempt at innovation is discouraged and departure from established rules regarded almost as a breach of discipline. An excellent illustration of the extent to which this sort of thing may be carried is seen in Major Scott-Moncrieff's excellent paper on tests of full-sized timber trusses, published in the *Journal of the Royal Institute of British Architects*, and discussing experiments made under his supervision at the School of Military Engineering, Chatham.

Early in the present century Tredgold wrote his monumental treatise on carpentry, and while there is much in the work which is undoubtedly yet of great value,—the knowledge of the strength of materials and of the action of stresses and strains was by no means as thoroughly understood then as now, and many of the rules and proportions were obtained empirically, or taken from successful practice.

Among other things Tredgold devoted a few brief paragraphs to the construction and proportions of timber roof-trusses, and upon these rules the whole of subsequent English practice has been based, the work having been adopted by the Engineer Department of the Army in 1844, and ranking as standard authority ever since.

An examination of the proportions given by Tredgold for timber trusses, however, indicates at once that they are by no means the best, or most economical that can be adopted. Thus he makes the tie beam much heavier than the principal rafters, notwithstanding the fact that under any conditions of loading the stress upon the latter must be the greater, while the arrangement of struts and the location of the purlins are such as in certain cases to cause eccentric stresses.

Believing that the empirical proportions generally used on Tredgold's authority might be successfully replaced by formulæ based upon a rational treatment, Major Scott-Moncrieff decided to make a series of comparative tests of full-sized trusses, using both the proportions given by Tredgold and those indicated by a consideration of the theoretical distribution of the stresses. As these tests were made upon trusses of 24 to 32 feet span, the results are worthy of especial note, since so many of the tests of timber upon which elaborate discussions have been based consist of trials of such small pieces as to render them of doubtful value.

The apparatus used was simple, and apparently very effective, consisting of hydraulic jacks applied at the purlin bearing-points upon the principals, the jacks reacting against a heavy steel beam to which the ends of the truss under test were also tied by sling-bars. The pressure exerted by the jacks at any moment was indicated by a pressure gauge mounted upon a reduction cylinder, the ram of the cylinder having an area of 50 square inches, so that each pound on the dial corresponded to 50 pounds actual pressure on the cylinder.

The tests demonstrated a number of facts which corresponded closely with the theoretical deductions. Thus in the case of a 28-foot king post truss, made not after Tredgold's proportions, but with tie beam and principals of the same dimensions, failure occurred, not by the yielding of either member as a whole, but by the shearing of the end of the tie beam because of the defective character of the joint. A 28-foot truss, made exactly according to the proportions given by Tredgold, failed by the buckling and splitting of one of the prin-

cipals, the struts also giving way, thus demonstrating the insufficient proportions of the compression members. Similar tests with queen-post trusses, and with modified proportions, sustained very generally the reasoning upon which the trials were undertaken, and while the number of tests was too limited to warrant broad conclusions to be drawn, the results were very satisfactory so far as they went.

The conditions of trial were not altogether identical with those which obtain in an actual roof, since the several trusses in a roof are stiffened against lateral buckling by the purlins. The tendency to lateral deflection was observed to a marked extent in some of the tests, and the desirability of introducing carefully designed lateral bracing between trusses was demonstrated, as was also the importance of providing means for tightening the various joints at will.

Altogether this work has resulted in furnishing some valuable contributions to our knowledge of the behavior of wooden trusses under load, and incidentally has shown on how insufficient a foundation some of the respect which is paid to a fine old crusted authority may be based.

Spontaneous Combustion in Coal Mines.

ALTHOUGH the fact that coal under certain conditions is liable to spontanous ignition has been known for a long time, there is yet a difference of opinion as the true cause of such action, or to the best precautionary measures to be taken.

In a paper by Mr. James Ashworth in a recent issue of the *Colliery Guardian* the relation between moisture and spontaneous combustion is discussed, and a possible cause for the ignition examined.

"Formerly it was thought that the oxidation of iron pyrites was the cause of spontaneous combustion in coal mines, but it was evident that this by itself was not sufficient cause, because it was noticed that some mines which contained large percentages of pyrites did not take fire spontaneously. Investigation has proved, and it is now generally admitted, that the absorption of oxygen by the very fine coal dust is the principal cause of spontaneous combustion in coal mines, but it is not so generally admitted that the dampness or dryness of the mine air-current has as much influence on the development of spontaneous combustion as the absorption of oxygen only."

This fact at once brings about a complication of affairs, for in order to prevent the propagation of explosions through dusty mines it has become a very general practice to sprinkle them, or to moisten the coal in some other way, and thus, while preventing the dispersion of dust to set up the most favourable conditions for spontaneous combustion.

Dust explosions are properly regarded as very serious, and every precaution should be taken for their prevention. The principal methods in use are those which include various systems of watering the coal, either by forcing water into holes bored into the seams, or by watering the coal freely in the trams; or else some method of fine sprinkling or spraying is employed. Another plan is to provide thoroughly wetted spaces or zones at intervals along the haulage roads, thus furnishing areas free from dust, through which explosions cannot be propagated.

So far as the action of moisture upon the ignition of coal is concerned, it appears, from the most careful experiments which have been made, that coal dust readily absorbs oxygen and water, and that the oxidising of the coal creates heat. If this heat does not exceed 250° F., spontaneous combustion will not take place, but if it reaches 356° F., the heat rises very rapidly and quickly fires the coal, and if, while the coal is exposed to a heat of 290° F., the air surrounding the coal is suddenly compressed, ignition will take place at once, and the combustion will be very fierce. Where the air of the mine is warm and damp, therefore, the margin of defence against fire is very small, and it is desirable that a thorough ventilation with a cool and dry air current should be maintained. When the workings are inclined the air current should be conducted down-hill instead of up-hill, in order to prevent the accumulation of heat and aqueous vapour otherwise found in the working places at the highest point of the face.

Apart from the danger of ignition, due to spraying the dust with water, the fact appears that water-spraying does not act

effectively to prevent dust explosions. Numerous examples of dust explosions have been observed in mines in which the workings were sprayed with water, and in investigating such explosions, as has been most thoroughly done by the Prussian Firedamp Commission in connection with dust explosions in Westphalia, it was demonstrated that the only means of arresting or preventing an explosion of coal dust from a blown-out shot is by wetting the dust with 50 per cent. of water, or, in other words, making it so wet that water may be squeezed out of it by the hand.

These facts indicate that a thorough wetting must be used to prevent dust explosions, and at the same time that dampening which permits the oxidising and overheating must be avoided so far as possible. These somewhat contradictory requirements are met as well as can be expected by the use of wetted zones or lengths of road not less than 70 yards in length. Experiments have shown that protected spaces of this character are sufficient to prevent the passage of an explosion, and by a judicious arrangement of these zones any dust explosion may be confined within the limits of its origin. The remainder of the mine need not be moistened at all, while these wetted sections can be kept wet enough to avoid overheating and can be watched for possible ignition more readily than with a general system of sprinkling.

"The more this subject is investigated the more clearly it will be demonstrated that it is not wise to water a mine which is subject to spontaneous combustion, and that a very dry and cool ventilative air-current is the best safeguard against spontaneous combustion and explosion from coal dust, and that until some better means of rendering a coal mine safe against an explosion of coal dust is discovered, a wet length of road or zone is the best protection."

Steam Speeds at Sea.

In the Watt anniversary lecture, delivered by Sir Nathaniel Barnaby in Greenock before the Watt Institute, the development of the speed of steam vessels is treated in an interesting manner, and some points in connection with recent advances especially discussed.

Mr. Scott Russell gave the Watt lecture in 1867, and Sir Nathaniel took occasion to compare the present state of steam navigation with that set forth thirty-two years ago. Not only has the steam tonnage, both in the merchant marine and in the navy, increased more than six-fold, but steam pressures have increased from 30 pounds to nearly 300 pounds. Piston speeds have been raised from 500 to 900 feet per minute, and the revolutions of the screw propeller have been increased in large ships from 75 per minute to 120, and in small vessels to over 400 per minute.

Thirty-two years ago the crack Cunarder was the Russia, and with 3,100 horse power she required three pounds of coal per horse power. The Cunarders of to-day develop nine times as much power, while the consumption of coal per unit of power has been reduced to two-thirds that of the Russia. The maximum speed attainable at the beginning of the present reign was 14 knots, while at the present time 34 knots has been attained on actual trial, and that too with a small vessel.

One of the most serious limitations which has been found of late to further increase of speed is the reduction in the efficiency of the screw propeller at high speeds, and this fact, first brought out by Mr. Thorneycroft in the trials of the Daring, led Mr. Parsons to use three shafts and nine propellers on the Turbinia. In applying the Parsons steam turbine to a large passenger vessel or war ship, using say, 30,000 horse power, it is estimated that four propeller shafts with two screws on each shaft would be necessary.

The original fashion for high speeds was set by the Armstrong firm in building some vessels for weak foreign navies in which speed was of great importance. Between 1880 and 1882 several vessels were built for China and for other countries, the most notable being the Esmeralda, which made 18¼ knots, and the Esmeralda type, sometimes with a narrow strip of side armour, but more often with none, was the beginning of the swift cruiser class now in high favour in all navies.

The experiences which have been had with modern swift vessels show that the behaviour of the water resistance undergoes a peculiar change after a certain point is

passed. The propelling power of a ship is largely expended in making trains of waves, and within certain limits the wave-making expenditure increases at a very rapid rate as the speed of the ship is increased. When the limit is reached there is an apparent change in the behaviour of the fluid through which the vessel is being forced, and the rate of increase in resistance is much less rapid.

In a vessel 185 feet long this change for the better begins at a speed of 24 knots, but for a vessel 500 feet long no improvement due to this action can be expected until she attains a speed of more than 100 knots, were such possible.

This accounts in part for the remarkable results which have been attained of late by small vessels, and precludes the possibility of such speeds being reached by larger vessels. The present tendency toward the building of large vessels is therefore to be expected to yield excellent results as to stability, comfort and capacity, but the very high speeds of the immediate future will in all probability be attained by the smaller ships.

The Protection of Iron from Rust.

IT is generally considered that the only thing needful for the full protection of iron is the prevention of contact with moisture, and therefore any paint which will adhere to the iron and will repel water is assumed to be a sufficient precaution. An exhaustive paper in a recent number of *Engineering*, shows, however, that not infrequently the paint itself may contain, or produce corrosive agents which may injure the very structure they are to protect.

One of the simplest and most generally used paints is discussed, i. e., a mixture of pigment, such as red oxide of lead (red lead), or red oxide of iron, with linseed oil. Such a mixture is practically the same as a soap, similar in all respects to a soap made by mixing an alkali with an oil or fat. Now, linseed oil consists of several organic acids, and of the radicle from which glycerine is formed and when the glycerine is eliminated by boiling with an oxide, the fatty acids are in a suitable condition to become oxidised into tough elastic skins.

If these simple chemical reactions could be perfectly carried out, the production of a good protective paint would be a simple matter, but in fact it is difficult to insure the complete separation of all the glycerine. Instead, therefore, of removing all the glycerine, it is attempted to render it harmless by absorbing it in some material for which it has an affinity. Such absorbing materials are found in oxide of lead, oxide of iron, or various resinates, etc., which are generally used in protective paints. In some paints the free glycerine is absorbed to a large extent; for example in red-lead paint the free glycerine is absorbed to the extent of seven-eighths, and in red oxide of iron it is absorbed to the extent of three-quarters, but in no paint is it completely absorbed, and in an effective protecting paint, therefore, some special substance must be used to complete the absorption.

"The compounds known as driers or siccatifs, which are added to paint for the express purpose of quickening the drying or hardening process absorb the pure glycerine. As a matter of fact, these driers are more often than not, compounds, which also, by decomposition, eliminate glycerine, particularly so those driers which are made by boiling litharge with linseed oil. Those driers which are compounds of manganese salts, or else resinates, are the most perfect compounds for absorbing—and therefore preventing mischief arising from —the glycerine."

The danger which arises from the use of a so-called protective paint which contains free glycerine, lies in the insidious manner in which it eats into the metal. The paint may appear all right, and may form a hard, smooth, and apparently impermeable coating upon the metallic surface which it is intended to protect, while at the same time it may contain in its substance, beneath the outer skin, a material which, being gradually released, is most corrosive in its action. In addition to the oxidation which the glycerine causes in the iron, it also causes the formation of blisters, and by reason of its affinity for water, it produces water-filled blisters, which gradually push up the paint and cause it to flake off. It is most essential, therefore, in the selection of a paint for the protection of structural works of iron or steel, to look for this most dangerous foe, glycerine.

THE CONTINENTAL PRESS

Review of Leading Articles

Electricity in Agriculture.

A VERY interesting review of the progress of the application of electricity in the various branches of farm work, with especial reference to recent experiments in Germany, is given by M. Paul Renaud in a recent issue of the *Bulletin de la Société d'Encouragement pour l'Industrie Nationale*, with many illustrations and data about this somewhat neglected branch of applied electricity.

It is only on the large farms that steam-power machinery can be installed to advantage, the intermittent character of the work and the high cost of the plant render it impracticable for small places; but, when power can be distributed from central stations to agricultural districts within a considerable radius at a reasonable cost, it can be utilized in many effective ways.

The production of the current for use in agricultural districts may be accomplished in various ways, being influenced mainly by local conditions. When waterpower is available, it can generally be used to much advantage; otherwise steam, oil, or gas engines are employed. Use of wind power in connection with accumulators has been suggested, but the extremely irregular character of this motive power has caused it to be used only in a few experimental instances.

In practice thus far the continuous current has been most extensively used, but at present applications are being made of the high-tension alternating current, using transformers at the points of application, and three-phase currents are strongly recommended by M. Renaud.

On the farm, as elsewhere, the main applications of electricity are for power and for lighting, but the peculiar nature of the work renders special appliances and methods necessary. Much of the work on a farm not only is out of doors, but also is distributed over a large area, requiring portable machinery and ease of manipulation and transportation.

Naturally one of the most important applications of power in agricultural work is that of plowing, and much space is given to descriptions of various forms of electrically-driven plows. In this line of work little has been done, except to substitute electricity for steam power in connection with forms of machine-plows already in use. Cable-drawn plows are much better adapted for general work than those hauled by traction engines, and the only difference between steam and electric plows is the substitution of a truck with motor, gearing, and suitable winding drum, for the portabel engine otherwise used. Plans are shown of the manner in which electric power may be distributed from a central point to plowing-machinery in a number of fields at the same time; and, by the use of electric cables carried upon portable drums temporary connections may readily be made from a central distribution point to fields within a reasonable distance.

Another very useful application of electricity in agriculture is that of traction. Hauling by steam power has never been very practicable in connection with farm work, but, when electric power is available, it is possible to install, at moderate cost, a system of light railways, connecting the various buildings and fields, and, by means of an overhead trolley, to do most of the hauling by power.

Agricultural trolley roads of this sort have been established with much success in Holland, in connection with the cultivation of the sugar beet; and the various sections of track, trolley poles, and connections are now made of standard sizes in stock, thus enabling roads of this sort to be constructed rapidly and economically.

The overhead cableway, for handling hay, wood, and other materials, finds many useful applications on the farm in connection with electric power, and the combination of the cableway and hay grapple enables large quantities of hay to be stacked by power very rapidly and effectively.

Electricity has also many possible applications on the farm for general power pur-

poses, and numerous examples are given of the driving and threshing machines, hay cutters and presses, pumps, sheep-shearing machines, and other varieties of farm machinery. The use of electric lighting in agricultural work, apart from the replacement of the ordinary lights now employed, is limited mainly to emergency-illumination out of doors, arc lamps being suspended from poles, and supplied with current by means of portable cables, much as in contractors' work.

The general advantages of electric power in agricultural work are being perceived more rapidly in Germany than elsewhere in Europe, although in France M. Felix Prat has labored with much energy and success in this field. Some apprehensions are felt as to the possible opposition of ignorant farm-hands to the introduction of machinery which will supersede hand labour in many ways, but it is hoped that difficulties from this source will be overcome, as they have already been in the case of other agricultural labour-saving machinery.

Central Condensers.

THE advantages of condensation of steam are well-known, but, in many cases the gain does not warrant the introduction of the additional mechanism, and to have an independent condenser for every steam pump or small engine would be as undesirable as to have a separate boiler for each.

The whole principle of the use of steam is that of difference of pressure, which involves difference in temperature, and since many engines are supplied from one battery of boilers it is only reasonable that in large plants it should be though advisable to install one central condensing plant, into which all the steam cylinders should exhaust. In such an arrangement the boilers constitute a reservoir of positive pressure and the condenser one of negative pressure, the difference between them being that utilized by the engine.

In many cases the possibility of using such condensing apparatus depends upon the available supply of water, and hence the problem is complicated with that of providing an ample supply of cold water, or of the use of some method of cooling the same body of water for repeated use.

Various installations of central condensing plants have been made in Germany during the past twenty years, and the popularity of this method has greatly increased of late, and in a paper by Herr Chr. Eberle, in *Stahl und Eisen*, a general discussion of the theory and practice of the system is given, with numerous examples of the special forms made by German constructors.

The theory of such condensers does not differ in principle from that of ordinary constructions, but it is desirable to have the relations stated in the form of equations in order that the effects of various temperatures of condensing and discharge water upon the vacuum may be noted. When the supply of condensing water is limited, and artificial cooling devices are used it is desirable to limit the quantity of water to the least amount consistent with a satisfactory vacuum, and these points may be computed beforehand within practical limits, so that the proper proportions of the apparatus may be determined.

As in the case of smaller apparatus the central condenser may be either of the injection or the surface type. Some of the earlier forms were made as injection condensers, the water being delivered into direct contact with the exhaust steam, one of the most effective designs being arranged with a series of drip pans, placed one above the other, the water flowing downward from one pan to the next in thin sheets, the current of steam moving in the opposite direction to the water, the whole being placed high enough for the discharge water to flow out by gravity, leaving only the entrained air to be removed by pumping.

In general, however, it is preferable to use surface condensers rather than to have the condensing water mingle with the condensed steam, as a surface condenser delivers water for the boiler-feed free from any soluble salts which would form scale. The formation of scale, however, which is thus prevented in the boiler, may be transferred to the condenser under certain conditions, and Herr Eberle devotes a portion of his paper to the action in such condensers of waters containing salts in solution. The carbonates of lime and magnesia are deposited whenever the temperature of the

water is raised sufficiently high to drive off any of the carbonic acid, and even before this temperature is reached the solution is diminished, so that more or less precipitation occurs.

If, however, the temperature of the discharge water is not permitted to rise above 50 degrees to 60 degrees C. (122 degrees to 140 degrees F.) no inconvenience from this source will occur, while sulphates require a still higher temperature for precipitation.

When plenty of condensing water is available a surface condenser for a central plant does not differ materially from the independent condensers made for marine service, the water flowing through tubes passing through a closed vessel into which the steam is discharged and in which the vacuum is maintained; an air pump being used to remove the accumulated air and water. Sometimes modifications are made, such as passing the steam through the tubes, or special forms with flat condensing surfaces are employed.

When, as is frequently the case, the supply of condensing water is limited, some form of cooling apparatus must be used, and it is to the development of this form that mechanical ingenuity has of late been directed. The earliest plan, one which has been used for many years both in England and America, is that of a shallow pond, into which the hot water is delivered, and in which it is compelled to traverse a circuitous path from one end to the other, the contact with the air cooling it sufficiently to permit its use again in the condenser. In some of the later German cooling ponds shown by Herr Eberle, the hot water is discharged as a spray from numerous nozzles, thus being brought into intimate contact with the air, and rapidly parting with its heat.

The latest forms of surface condensers are those of the evaporative type, in which the steam passes through nests of tubes upon which water drips, the whole being inclosed in a chamber through which a powerful circulation of air is produced by a fan blower.

The evaporation of the water from the surface of the tubes abstracts the heat very rapidly, and the formation of steam within is practically effected by the formation of steam without, so that a very small quantity of water is required, clouds of vapor being driven off with the air discharge, and only the excess dripping to the tank below. Although this system requires a constant expenditure of water the quantity is so much less than is needed for contact condensation, that these evaporative condensers are finding wide application in all parts of Germany.

The installation of a central condensing plant effects much greater economy than that due merely to the vacuum attained in the main driving engines, since all the minor steam engines, pumps, etc., deliver their exhaust steam into the common exhaust main, and as these auxiliary machines are among the most wasteful of steam the application of a vacuum to their cylinders enables them to be operated with a proportionally greater economy than is the case with better designed engines.

Herr Eberle's paper contains many illustrations of the condensers of the best German makers and is well worthy of examination by power plant engineers.

The Progress of the Siberian Railway.

In view of the important international significance of some of the modifications in the route of the Trans-Siberian railway, the progress of the work is attracting renewed interest, and, in a recent issue of *Le Génie Civil* M. de Batz gives a general review of the present state of the undertaking, in connection with the railway work in eastern China.

The change by which the original route along the valley of the Amoor was replaced by the line through Manchuria has already been fully discussed in these columns, but, when the modification was first made public, it was stated to have been selected entirely for constructive reasons, the terminus on the Pacific coast still being Vladivostock.

It is now apparent, however, that the true terminus is to be Port Arthur, and, while Vladivostock will also be reached, there is little doubt that political reasons, as well as engineering features, had much to do with the choice of the route through Chinese territory.

The railway was at its origin undoubtedly a military project, and, as Vladivostock

was the base of action of the Russian fleet in the Pacific, and the location of an important arsenal, it was naturally the only terminus considered. After the events of the war between China and Japan, and the entrance of Russia into the settlement of the questions which followed, the desirability of shortening the route of the railway was made a pretext for the negotiations between Russia and China for the right of way through Chinese territory, and this was followed by the financial arrangements with the Russo-Chinese Bank and the entire revision of the scheme of the Trans-Baikalien portion of the railway.

A glance at the map of the revised route shows that, as the coast is approached, it is necessary to turn toward the north to reach Vladivostock, while at about the same distance on the south lies Port Arthur, possessing numerous advantages, and free from ice throughout the entire year. These reasons appear to be of sufficient importance to warrant the selection of the terminus and harbour, which is not in Russian territory, but which is undoubtedly within the so-called "sphere of Russian influence."

The importance of realizing the advantages to be gained from these recent concessions has caused work upon the Manchurian end of the railway to be pushed forward with all speed, and M. de Batz gives data showing the energy which has been put into the various sections of the road since the details of the route have been finally settled.

The Siberian railway properly begins at Tcheliabinsk, at the boundary between Europe and Asia, in the Urals, and the western section, of 860 miles in length, reaching to the Obi, is completed and in operation. The central section comprises that portion between the Obi and Irkoutsk, and consists of two divisions. The first of these, from the Obi to the Yenesei, 470 miles, is completed, but the second portion, including the great bridge over the Yenesei,—one of the most important engineering features of the road,—has progressed more slowly, though it is expected to be finished early in the present year. A large part of the permanent way on this portion is finished, and in operation; but, until the bridges are finished, the passengers and merchandise must be transported by ferries. There is no doubt, however, that before the middle of 1899 all the bridge work will be completed, and also the short line from Irkoutsk and Lake Baikal, and that there will then be a through railway line from the Urals to Lake Baikal—a distance of 2,000 miles—in active operation.

It is at Lake Baikal that the Manchurian section of the road begins, the official name of this portion being the Eastern Railway of China, and it is on this portion that efforts are now to be concentrated.

M. de Batz gives some interesting accounts of his experiences during a journey over the road from Tcheliabinsk to Lake Baikal, and, as a number of the connecting links between the various sections were at that time uncompleted, the journey included some tedious connections by ferry and wagon, which are now replaced by railways.

A number of illustrations accompanying the article referred to give an excellent idea of the substantial character of the station buildings at various points along the completed portion of the road, and a map shows the status of the work on the new part, together with the important connections to be made with existing railways. The proposed extension to Port Arthur will connect directly with the partially-constructed road from Newchwang to Pekin, and, unless diplomacy interferes to modify this portion of the plan, the communciation between the capitals of Russia and China will be uninterrupted, and over no territory other than that of the two nations directly interested.

Compression in Steam Cylinders.

It is no more than a year since Professor Dwelshauvers-Dery announced, as the result of the investigations with his experimental engine at Liége, that compression in a steam cylinder is essentially a wasteful operation, and that it cannot be considered at all as a satisfactory means of overcoming the injurious effect of clearance.

Such a contradiction of the hitherto-accepted dictum of Zeuner, and so apparent a disregard for what had been supposed to be the teaching of experience, naturally attracted much attention and no little comment: and Professor Dery's original paper,

which appeared in the *Revue de Mécanique*, received some severe criticism, notably from the pen of Professor Boulvin, of the University of Ghent. In consequence, the whole subject of clearance and compression has received a thorough overhauling in many quarters.

In a recent issue of the *Revue de Mécanique* Professor Dery contributes a paper upon the practical theory of the steam engine, and there is also a paper upon the subject of clearance and compression, by Professor Anspach, of the University of Brussels, both papers containing interesting matter upon this much-discussed subject.

The article of Professor Dery is devoted mainly to an elementary discussion of Hirn's analysis of the action of steam in a cylinder, which, he affirms, is based upon the two fundamental principles of the indestructibility of matter and of energy. Two complete cycles of action are then examined, one relating to the working fluid and the other to the containing metal, and the corresponding equations for the successive periods are deduced.

Some interesting points are given as to the precautions and methods to be observed in the conduct of a test, in order that reliable data for use in connection with Hirn's analysis may be obtained, after which the data of the experiments at Liége are given and the analysis applied.

As the tests undoubtedly indicate a definite loss, increasing with the degree of compression, some means of accounting for the fact must be found, if the loss is not to be attributed to the compression. If it is due to the presence of moisture in the cylinder at the termination of the exhaust, as has been suggested by the experiments of Mr. Bryan Donkin, there appears to be a defect in the analysis of Hirn, but, otherwise, Professor Dery asserts that his position as to the wastefulness of compression is fully sustained.

The paper of Professor Anspach is mainly a review of the discussion between Professors Dery and Boulvin, and, while the accuracy of the Liége experiments and the truth of the losses with increasing compression are not questioned, yet doubt is expressed as to the competence of the present theory to explain the phenomena, and especially as to the wisdom of depending closely upon conclusions drawn from minute changes in the form of indicator diagrams. Rather is the true theory of the action of steam in a cylinder yet to be enunciated, and, not until after many laborious experiments made with care and skill equal to those exercised by Professor Dery, can we expect to possess a sufficient mass of data to enable us to arrive at the laws governing this complex subject.

The Electric Motor in the Machine Shop.

It is now generally admitted that electricity is the coming method for the distribution of power to the various tools in machine works, and in many instances it has already arrived.

As might be expected, the earliest users of motors for individual tools were the manufacturers of electrical machinery, and in a number of the establishments where dynamos, motors, and other electrical machinery are made, belting and shafting have been abandoned to a great extent, and electric driving substituted. This is notably the case in the works of the *Allgemeine Elektricitäts-Gesellschaft* at Berlin and in a recent issue of the *Zeitschrift des Vereines deutscher Ingenieure* an excellent account is given of the arrangement of the machinery in this important establishment.

The older part of these works was arranged for belt driving, and in some portions the old system still remains, but as the capacity was increased and new buildings added, electric driving was installed and thus excellent opportunity given for comparison of the two systems.

Among the first machines to be operated by electric motors were the travelling cranes and other hoisting machines, their especial adaptability for this purpose being apparent from the ease with which the electrical connections permitted power to be delivered to the moving bridges.

Some pumps, situated in inconvenient locations for power transmission, were the next application, and as new special tools were added electric driving was in nearly every case applied, either by the use of separate motors, or in the case of smaller machines, by "group" driving, sections of shafting being operated by motors, and

belt driving being employed only from the motor-driven shaft to the tools.

As is usually the case, a growing establishment cannot be planned out entirely beforehand, and one of the greatest causes of waste in power transmission is the effort to get the power around corner, and across inconvenient spaces. With electric transmission such difficulties disappear, and for like reason the time-honored system of arranging the position of tools in the shop with regard to the direction of the line shafting, instead of convenience of handling material, no longer appears. Lathes may be placed in rows across the room, small machines may be put anywhere, as may be most convenient, and operative considerations generally permitted to govern the location of tools, since the power can be transmitted anywhere with perfect ease.

Some views of the interior of the old and new parts of the works are most convincing object lessons of the great advantage of electric driving of machine tools by independent motors; and the contrast between the wilderness of overhead belts, pulleys, and shafting, with the light, clear space above the machines in the new portion, speak louder than any words as to the advantages of electric driving.

There can be no doubt whatever, that the machine shop of the immediate future will have electric motors used for all tool driving, and that belting will be used only in a few special cases. Machines will be placed where they can be most conveniently driven, the location of building will no longer be decided by considerations of power transmission, and one of the greatest causes of the waste of power will be almost entirely eliminated.

The Progress of the Diesel Motor.

SINCE the rather dramatic announcement of the invention and successful operation of the so-called "rational" heat-motor by Herr Rudolf Diesel at the Cassel meeting of the Society of German Engineers in 1897, material progress has been made in placing the new motor before the public. A number of firms in Europe have undertaken the construction of the motor, and arrangements have been made for its manufacture in the United States, tests by Professor J. E. Denton having shown results confirming the high economy obtained in Germany.

A paper by Herr Dieselin the *Zeitschrift des Vereines deutscher Ingenieure* gives some of the more recent designs of the motor which have been made in Germany, and also discusses some of the experiences which have been obtained with the use of various fuels.

Several Diesel motors were shown at the recent exhibition in Munich, four of the leading machine works of Germany being represented; although the general principles were alike in all, there existed minor differences in construction, some of which are of interest.

The fundamental points of the Diesel motor have been described frequently, and may be summed briefly, as follows:

In a single-acting cylinder, air is permitted to enter on the first outstroke, and on the return stroke is compressed to a pressure of about thirty-five atmospheres. During the second out-stroke petroleum is injected into the cylinder, and, igniting from the heat produced by the compression of the air, burns, producing the energy which forces the piston out. The air which enters the cylinder is previously compressed in a separate pump, the final compression alone being given in the power cylinder. There is, therefore, but one power stroke in every four, the momentum of the fly-wheel being used to carry the motion through the remaining portion of the cycle. Tests of this motor have shown a thermal efficiency of about 38 per cent., while that of the best steam engines barely attains 15 per cent., and that of the best gas engines about 25 per cent.

The reasons for the attainment of this high economy are several. In his original presentation of the motor Herr Diesel showed that the highest degree of efficiency ought to be had by the realization of the Carnot cycle, using adiabatic compression and isothermal combustion; within practical limits, these conditions are fairly well attained in the motor. In addition to the use of an efficient cycle, however, the economy is enhanced in no small degree by the completeness of the combustion.

In the previous forms of gas or petroleum engines the fuel is admitted to the

cylinder at the same time as the air, and efforts are made to obtain such a mixture as will produce the best combustion; but the correctness of the mixture is often difficult of control, and consequently the combustion is frequently very imperfect. This is especially the case when, as in most gas engines, the regulation is effected by the hit-or-miss method, in which case there is often an excess of combustible after an explosion has been missed. The certainty of ignition and the completeness of combustion can by no means be assured, either with the hot-tube or the electric spark, and it is generally admitted that in most gas engines much of the waste is due to imperfect combustion.

If these conditions are true with the internal-combustion motor, how much more difficult is it to secure perfect combustion in a boiler furnace! A complete admixture of air with the fuel is practically impossible, and the entrance of cold air, and the proximity of comparatively cool boiler surfaces, are fatal to anything like a thorough combustion of the fuel, so that it is hopeless to expect any great advance in economy in this direction.

In the Diesel motor, however, the conditions are entirely different. The air in which the combustion is to be effected is compressed before any of the fuel comes in contact with it, and is also raised by this compression to a temperature far exceeding that of the ignition of the fuel. The petroleum is then injected into a space containing an excess of air above that needed for combustion, at a temperature above that required for a complete combination, the combustion being also assisted to a great extent by the compression.

Under these conditions it is found that the combustion in the cylinder of the motor is practically perfect, and there is no smoke given off with the discharge gases, nor is there any deposit of unburned carbon in the cylinder, even after prolonged periods of continuous operation.

The motor has been operated with a variety of liquid fuels, benzines, illuminating petroleum, fuel oils, such as "Eagle," Lima, and California crude oils, and the very thick naphtha residue from the Russian oil fields, known as "Masut," the latter having a specific gravity of 0.905. So far as the combustion is concerned, the character of the fuel appears to have no effect, there being no residue in any case, the heavy oil burning as completely as the light benzine, so that a material portion of the efficiency of the machine must be attributed to the perfection of the combustion. Experiments have also been made in Germany with the so-called "spiritus," a methylated alcohol containing from 10 to 15 per cent. of moisture, the results being equally satisfactory.

One of the latest forms of the motor, described by Diesel in the paper referred to, is a double engine, there being two cylinders side by side, with coincident cranks, but with the valve gear so timed as to cause the power strokes to alternate. This arrangement, similar to one which has already been used for gas engines, conduces to greater steadiness of motion by equalizing the action upon the crank shaft.

The Disinfection of Cattle-Cars.

THE determined efforts which have been made in various parts of Europe to prevent the spread of disease among cattle have led to the consideration of the best methods of preventing the contagion which may occur through the railway shipment of sound animals in cars which have contained diseased cattle on previous occasions.

A paper upon this subject by Herr Adolf Freund, in the *Zeitschrift des Oesterr. Ingenieur und Architekten Vereines*, gives an excellent account of the various methods of disinfection practised in Austria and Germany, and the subject is one which demands the careful attention of railway managers.

Accepting the bacterial origin of the diseases which are to be combated, it follows that any efficient method of disinfection must act to kill the pathogenic bacteria which may be in the car. It should be the invariable rule, however, that regardless of the use of any special disinfection, general cleanliness must be maintained, the cars being thoroughly washed out between trips with hot water. In many instances this is all that is necessary, unless there has been reason to suspect that infected animals have been transported. It is, however, so difficult to be assured of the healthy character of all the animals carried that the safest plan is to have some effective method

of sterilizing the cars for regular use at all times, with a reserve of powerful disinfectants for times of epidemic.

In addition to the regular washing, the methods used on the continent for disinfecting cattle cars are as follows:

Steam at atmospheric, or slightly higher, pressure is used in Austro-Hungary, Switzerland, and Russia; in the Netherlands higher pressures, up to six atmospheres (corresponding to 160° C.), are employed, sometimes alternating with chemical disinfectants.

In Belgium steam is used in connection with atomizing devices for the purpose of pulverizing liquid disinfectants. Hot alkaline solutions are extensively used, sometimes in connection with the regular washing, and chloride and sulphate of zinc are also used, the latter especially in France. Chloride of lime is a favorite disinfectant, and, in cases of epidemic, carbolic acid and bichloride of mercury are applied, the latter only in Italy and in the Netherlands.

In practice the use of steam appears to give excellent results, especially when the pressure is such as to insure a temperature high enough to destroy the germs. The experiments of Koch, Gaffky, and Loffler have demonstrated that, even with steam at atmospheric pressure, and hence only boiling temperature, all disease germs are destroyed in five minutes. A simple arrangement of piping will enable the steam to be introduced from the boiler of any convenient locomotive,—one of the advantages of steam over any chemical treatment. An excellent method of steaming the interior of a car, when heat is available but no steam can be had otherwise, is to heat a plate of metal to a high temperature, place it in the car, and pour water upon it; the steam given off will serve the purpose.

The use of chemical disinfectants involves several considerations, which must be observed if satisfaction is to be attained.

Most of the usual disinfecting materials, according to Gruber, cannot be depended upon to destroy contagious germs at ordinary temperatures, unless used in very strong solutions. Even a 5-per-cent. solution of carbolic acid has been found unequal to destroying the germs, when used cold, and in any case the persistent odor is most objectionable, if the cars are to be used for the conveyance of any other kind of merchandise.

The influence of heat in increasing the efficiency of disinfectants has been fully demonstrated, and, in the case of carbolic acid or formaldehyde, it appears to be essential, but experience on the Austrian railways show that a filtered solution of chloride of lime (5 per cent.), when used as a cold spray, can be depended upon to destroy the germs in a very effective manner. If the metal work of the car is protected by a barium paint, any action of the chlorine upon the metal is prevented and the simplicity, safety, and convenience of the method, added to its efficient action, render it, in the opinion of Herr Freund, the best process that can be adopted.

The Melan Bridge at Steyr.

THE importance of the combination of concrete and structural steel for bridge construction is made evident by the increasing use of this method both in Europe and America.

A recent application of the Melan system is seen in the new bridge at Steyr, in Austria, of which a well-illustrated description is given by Professor Melan in a recent issue of the *Zeitschrift des Oesterr Ingenieur und Architekten Vereines*.

The Melan system is especially adapted to flat arches, that at Steyr being of 42 metres' span by only 2.85 metres' rise.

The bridge consists of six lattice arches formed of plates and angles, with hinges at the crown and springings, these arches being completely imbedded in concrete consisting of 1 part of Portland cement, 2 parts of sand, and 4 parts of broken stone. The moulding of the concrete was performed so as to provide for the free movement of the hinges of the metallic arches, while at the same time the concrete surrounds the halves of the arches in such a manner as to form each half of the bridge into a monolith of concrete containing a structural metallic skeleton.

The tests of the bridge, conducted with much care, showed a maximum deflection of only 39 milimetres (1.53 inches) under a full load of 460 kilogrammes per square metre, or about 92 pounds per square foot.

THE AMERICAN PRESS

Review of Leading Articles

By-Product Coke Ovens.

AMONG the papers presented recently before the American Institute of Mining Engineers, are two which give opposite points of view of a very important industry, which, in the United States, at least is hardly up to the status of other branches of metallurgy. One of these papers is an account of the bee hive coke-ovens in the New River District of West Virginia, by Mr. Charles Catlett, while the other is a description of the Semet-Solvay by-product oven plant at Ensley, Alabama, by Mr. W. H. Blauvelt.

By far the greater portion of the coking in the United States is done in ovens of the bee-hive type, notwithstanding the low efficiency of this primitive contrivance and the entire loss of all by-products which their use entails.

From analyses given of the coal used by the New River Coke Company, there should have been only about 3 per cent. of ash, and the theoretical product of coke should be about 75 per cent. As a matter of fact, the majority of the ovens in the district do not yield 60 per cent., and observations indicate that many of them run less than 55 per cent. This appears to be much lower than should be obtained, and indicates that, in addition to the volatile matter, about one-fifth of the coke is burnt up in order to secure the other four-fifths. This poor economy in attributed by Mr. Catlett to an excessive amount of air, but even with the best of air regulation, the inherent defects of the old type of oven are such as to render the best efficiency impossible.

The by-product coke ovens described by Mr. Blauvelt represent a far higher grade of practice, and show that even in so simple a process as that of coking coal there is room for much ingenuity in design and in operation.

In the Semet-Solvay oven the coking is performed in retorts, or rather chambers, which are filled with coal and tightly sealed, the heating being effected by means of flues in which gas is burned between the chambers. This gas is a portion of what is driven off from the coal, and by its combustion with hot air a high temperature is readily maintained in the flues. The heat passes through the thin walls of the flues into the coal, which undergoes a true distillation, the volatile matter passing off without coming in contact with any air; consequently no combustion takes place. There is, however, a little breaking down of the hydrocarbons by the action of the heat, and a deposition of carbon that causes the retort-oven to yield a higher percentage of coke than the theoretical, while the beehive oven yields less than the theoretical, owing to the partial combustion of the fixed carbon that takes place.

In the by-product oven the gases delivered from the retorts are delivered to a collecting main, and by being allowed to bubble through water a portion of the tar and ammonia are condensed and saved. A second portion of tar and ammonia is removed by the use of tubular condensers, and the last traces abstracted by a scrubbing apparatus, after which the cooled and purified gas is used for burning in the flues.

In this way from 15 to 25 pounds of sulphate of ammonia and 5 to 14 gallons of tar are obtained from a ton of coal, and from 8,000 to 11,000 cubic feet of gas. Only 5,000 to 6,000 cubic feet of gas are required to heat the ovens, and the waste heat is also available for the necessary steam-making purposes, and the remainder of the gas is available for any purposes which may require it. In the case of the coke ovens at Ensley, the surplus gas, which amounts to some two million cubic feet per day, is to be used in the steel mill for soaking pits, drying ladles, and as an auxiliary to producer gas in connection with the open hearth furnaces; and being of a better quality than producer gas, will be found most useful. It might also be made available for the direct production of power in gas engines, although apparently this application has not yet been attempted.

The comparison of these two coke-making plant affords a contrast well worthy of consideration. On the one hand a primitive and wasteful method, yielding little more than one-half of the theoretical quantity of the main product, and wasting all the marketable by-products, and on the other hand, a plant giving fully 100 per cent. efficiency in coke, besides yielding valuable commercial by-products, together with heat and power far above what is required for the demands of the plant itself.

Dr. Johnson once defined a weed as a plant, of which the use had not yet been discovered; perhaps we might equally well define a by-product as something valuable which most people willingly permit to run to waste, and in these days of close competition the difference between waste and economy frequently means all the difference between commercial failure and success.

Wooden and Masonry Dry Docks.

In view of the present urgent need of additional docking facilities for the United State Navy, and the general desire for a higher grade of construction than that which has heretofore been employed in this work, a discussion of the relative merits of masonry and timber dry docks was recently held before the American Society of Civil Engineers, and some important and useful information elicited.

In the discussion, which was opened by Professor William L. Cathcart and Commodore Mordecai T. Endicott, U. S. N., the only advantage which could be indicated for the timber construction was that of lower first cost, but doubtless few of those who have advocated the building of wooden docks as a measure of economy have realized the greatly increased cost of maintenance of timber over masonry, as shown by Professor Cathcart.

Thus in the case of the stone dry docks at Boston and at Norfolk, Va., 31 years in the first case, and 15 years in the second, the average costs for maintenance have been $2,000 and $1,251 per year; and at Brooklyn, where the conditions as to foundation have been very unsatisfactory, the maintenance cost averaged $4,680 per year.

The timber dry docks at the various navy yards make a very different showing. The apparent cost for maintenance, taking into account only the charges for current repair work, is very low in every case, but, unlike the masonry docks, the maintenance is of a kind which cannot maintain the dock in continual good order, the structure deteriorating from the very start. In all cases the decay, yielding and general deterioration have made large appropriations for reconstruction necessary, and charging this work to maintenance, where it properly belongs, it is demonstrated that one of the timber docks at New York has cost over $30,000 per year for maintenance, and the other one more than $85,000!

According to Commodore Endicott a timber dry dock must practically be rebuilt in from 20 to 25 years, and the experience of the navy shows that the expenditures required to keep them in condition aggregate finally several times as much as those for masonry docks, while the repairs to the latter are very small indeed.

The greatest danger to a dry dock is the upward pressure in the soil beneath the level of high tide, acting from without, and this can of course best be resisted by a masonry dock. The only way in which the stability of a timber dock can be preserved is to let the water in and pump it out, and in many cases serious injury has resulted to timber docks, particularly about the entrances, from this cause.

"The British government owns or controls 62 graving docks. Only one of these is of timber, namely, at St. John's, Newfoundland, which was built by the Newfoundland government. France has 36 graving docks, all of masonry; Germany has 11, all of masonry. A large dock recently designed for a private corporation, to be subsidized by the German government, was to have been built of timber, but the government refused to give the subsidy unless it should be built of masonry. Italy has 12 graving docks, all of masonry."

In view of the overwhelming preponderance of testimony as to the advantages of masonry docks, both as to safety and economy, when maintenance is taken into account, it seems as if the construction of any wooden docks by the United States government can hardly be considered as a possibility, and if such action is taken it will be in the face of the best expert opinion and

Heavy Rail Sections.

THE great increase of railway speeds, together with the increase in the weight of engines and trains, all of which has occurred in comparatively few years, has only been made possible by the employment of far heavier rail sections than would formerly have been considered possible or desirable, and in a paper before the recent meeting of the American Institute of Mining Engineers, Dr. P. H. Dudley reviews the important results which have been obtained by the use of stiff and heavy rail sections during the past fifteen years.

Express trains of 8 to 12 passenger coaches, drawn by locomotives weighing 100 to 110 tons, are regularly sent out to make schedule speeds between terminals of 45 miles per hour, involving intermediate speeds of 50 to 60 miles, while freight trains of 50 to 75 cars of 60,000 pounds capacity are drawn by one locomotive. Solid mail trains of 6 to 8 cars are run from New York to Chicago, 1,000 miles, in twenty-four hours; and shorter trains are running from Chicago to San Francisco, 2,000 miles, in three and one-half days.

Within the past fifteen years freight cars of 20,000 pounds capacity and about the same dead weight, have been replaced by cars of 60,000 pounds capacity and a dead weight of only about 45 per cent. of the capacity, while a number of 80,000 pound cars have been constructed, and are in service, and some of 100,000 pounds capacity have been made.

These are some of the results which have been made practicable by the use of heavy and stiff rail sections in the past, and there appears to be no prospect that the end has been reached. On the contrary, both the static wheel loads and the speed of trains are increasing, and the severer requirements of service must be met largely by applying principles now well known to prevent the generation of large destructive dynamic forces under the moving trains and by raising to a higher efficiency, in an economical way, everything which appertains to transportation.

The advantages attained with stiff and heavy rails are due, not only to the reduction in dynamic effects, but also to the distribution of the load over larger areas of the road bed, so that the heavier static loads with the lessening dynamic loads are not so destructive to the ties and the road bed as was the case with the lighter static and dynamic loads on the weak rails formerly employed. This is conclusively proved by the fact that a higher standard of track is maintained with the heavy rails, notwithstanding the greater volume of traffic.

Mr. Dudley gives numerous examples of the effects of the gradual advance since the laying of his pioneer 5-inch 80-pound rail, in 1894, showing the considerations which governed the distribution of the metal, and the successful efforts to obtain a steel which should be tough, quite hard, and yet not brittle, and shows how the manufacturers have kept pace with the demands upon them.

No mathematical analysis has been able to satisfy the complex conditions of stress which exist in rails in service, and the actual magnitude and distribution of the stresses can only be determined experimentally in the track by the use of some such apparatus as the stremmatograph, used with such success by Dr. Dudley.

An important point in this connection is the fact that the short duration of the stresses permits them to be much larger than would be permissible in bridges and similar structures. In many cases it has been clearly shown that with the former light rail sections stresses exceeding the elastic limit occurred, a marked set being observed.

Dr. Dudley's paper contains much that is of interest to the railroad man as well as the manufacturer, and in view of the results which have been attained in the past there is every reason to believe that the remaining problems in rail design and construction will be solved in close accordance with the actual conditions of service.

The Inter-Continental Railroad.

THE publication of the handsome and very complete report of the several survey parties which have been at work on various parts of the proposed route to connect the railways of North and South America is the culmination of an undertaking which has been before the public for the past nine years.

The report consists of four large volumes

and three cases of maps, the volumes containing numerous illustrations, from photographs, and being printed in both English and Spanish, while many of the maps are very handsomely executed.

The object of the survey was to ascertain the practicability and probable cost of a railway to connect the systems of the United States and Mexico with those of South America, and the work was conducted by three parties, composed of military and civilian engineers, 85 per cent. of the total cost of $288,586 being borne by the United States Government, and the balance by Brazil, Equador, Bolivia, and the Central American States.

The work done by these parties was naturally very unequal, but it all shows care, energy, determination and good judgment in overcoming unforeseen obstacles, and portions of the volumes form most interesting reading, apart from their value as records of engineering work. The first party, under Lieutenant M. M. Macomb, U. S. A., was well equipped with instruments for field astronomy, and also carried mercurial and aneroid barometers for altitude determinations. Much of the territory covered by this party was included in a rough triangulation, the principal points being checked by astronomical determinations, and all three parties united in completing a preliminary railroad survey, using transit, stadia measurements, odometer, and barometers.

The result is a fairly reliable survey showing the probable route to be followed for the construction of the railway necessary to complete an all-rail route between New York and Buenos Ayres, the distance between the two cities being 10,228 miles, of which 4,772 miles are now in existence, and 5,456 miles remain to be built. It is estimated that the cost of building the remaining portion of the line will be $175,000,000, and that there are no serious physical obstacles to its construction.

As to the commercial side of the question the report is silent, and indeed it was not upon this portion of the subject that it was expected to speak, excepting as to the estimated cost of the work. The commerce between the two Americas is not at present so great but that the cheaper water communication is amply capable of providing for it, but we have all heard that "facilities create traffic," and such a road would naturally have to depend to a great extent upon the local traffic to justify its existence. It must not be forgotten that all the early arguments for a railway to the Pacific were based upon the supposed demand for communication with the Far East, a consummation which now appears to be approaching, but for which the Pacific railroads might have waited long for revenue. The Inter-Continental Railway may not, probably will not be built for many years, but these difficult surveys, well recorded in this excellent report, may some day bear much the same relation to a great completed work as does the well-known series of volumes of Pacific railway surveys to the many lines which now cross the North American continent.

Improvements in Boiler Material.

THE demand for high steam pressures, especially in marine practice, has worked a revolution in boiler design and construction, and as a natural consequence, there has arisen a demand for boiler material of quite a different grade and character from that formerly acceptable.

The recent advances in the manufacture of high-grade boiler and pipe material form the subject of an important paper in the *Journal of the American Society of Naval Engineers*, and some of especial requirements of the Bureau of Steam Engineering of the United States Navy are there given in detail.

The cumbrous Scotch boiler is now distinctly regarded as old style, and the lighter water-tube boiler, with its practically limitless possibilities in the way of providing steam at any desired pressure and within the shortest possible time, comes in with an initial jump of 100 pounds per square inch over the upper limit of recent custom It does not appear, however, to be half as much of an innovation to design boilers for pressures of 250 pounds, with a reduction to 200 pounds at the engines, as it did twenty years ago to use steam at 100 pounds with the introduction of compound engines, prior to which working pressures rarely passed the 50 pound mark.

Of late years, and indeed, ever since mild steel set out to replace wrought iron, there has been continuous and rapid progress in

the art of manufacturing this material, until any desired quality can be uniformly produced by the most careful makers. The thorough inspection and severe tests which have been imposed by the Bureau of Steam Engineering have assisted very materially in the advances which have been made in the art of steel making in the United States, with a result of almost entirely eliminating the elements of unreliability and non-uniformity.

Much attention has been directed to the advantages of nickel-steel for bracing and rivets, and in the case of nickel-steel rivets with a tensile strength of more than 75,000 pounds and an elastic limit of 40,000 pounds, a much smaller rivet may be used than formerly, thus requiring the cutting away of much less of the original plate for holes. The especial adaptability of nickel-steel for braces and rods is also clearly shown, and the toughness and uniformity shown by the test specimens are remarkable.

An interesting comparison of the practice of the Bureau of Steam Engineering in the requirements for boiler materials is given by the publication of the specifications for the boilers of the Maine, built in 1888, and those issued in 1898 for the torpedo-boats, monitors, and battle ships now under construction.

Thus, ten years ago, the requirements for shell plates were: tensile strength between 58,000 and 67,000 pounds, with an elongation of 22 per cent., and an elastic limit of 32,000 pounds. The corresponding requirements of to-day are: tensile strength, between 74,000 and 82,000 pounds, elongation 21 per cent., elastic limit 40,000 pounds. In 1888, rivets and stay rods were required to have a tensile strength of 50,000 to 58,000 pounds, and in 1898, of 75,000 to 85,000 pounds, and the other requirements show a corresponding advance.

Boiler tubes, fittings, and steam and water pipes are now subjected to greatly increased pressures and require correspondingly increased care and attention. Steel is generally used as the material and lap-welded steel pipe is made of such quality that sharp angle flanges can be turned and pened cold without developing any cracks or flaws. Seamless-drawn pipe is now also used to great advantage, and solid flanges are welded to these pipes with perfect success, or still more recently, the end of the pipe has been upset and then by spinning the end over under hydraulic pressure, a flange can be made wholly in one piece with the pipe. Wrought steel fittings are recent additions to the resources of the engineer in making high-pressure steam connections, and the advantages which they possess over the bulkier and less reliable castings are obvious. The importance of the development of boiler and pipe material of the highest grade will be appreciated when it is realized that it is from increased steam pressures that much of the hoped-for progress in steam engineering must come. Higher pressures mean greater expansion, greater power in smaller compass, greater economy and greater reserve power in time of emergency; and in marine practice especially it is for the great emergency that everything must be designed. It is from the boiler that the power must come, and into the boiler should be put the very best material the skill of man can produce.

Water Filtration at Pittsburg.

THE general interest which is taken in the subject of the purification of drinking water, and the decided tendency toward the use of sand filtration as a means of removing injurious impurities, renders every record of actual practice important. The presentation, therefore, of the report of the filtration commission of the city of Pittsburgh, Pa., after the installation and operation of a modern filtration plant, is especially worthy of record, and from the account given in the *Engineering Record* we make a general abstract.

The city of Pittsburgh is supplied by the Allegheny and the Monongahela rivers, both of which stream receive the drainage of numerous towns, and are therefore polluted to an extent and manner altogether beyond the control of the Pittsburgh authorities. The water of these rivers is also very turbid, even under ordinary conditions, while after heavy rains the amount of suspended mud is particularly objectionable.

It was this presence of mud which caused the city councils to hesitate about introducing sand filtration, since sand filters, although well-known to be the most efficient

means of removing bacteria, had in no case been used to filter water so muddy as that from the Allegheny river. Mechanical filtration, which is successful in removing mud, is not considered so effective with regard to bacteria, and hence it was thought advisable to make comparative trials before installing the entire plant. Experiments were therefore made with one sedimentation basin, two sand filters, and three forms of mechanical filters.

The sand filters were about 25 by 13 feet, and were run at a rate varying from two to five million gallons per day, the rate appearing to have no influence upon the bacterial efficiency. Whenever the loss of head due to the resistance of the filter reached four feet, the filters were scraped, and then filled with filtered water from below. The efficiency of these filters was excellent, reaching 99.21 per cent. in one case, and 98.92 per cent. for the other, during a period of 13 months. The average number of bacteria in the raw water was 16,340, and the average number in the effluents in the beds was 129 and 177.

In order to examine the effect of turbidity, one filter was used with raw water, and the other with water from the settling basin, and when the water was very turbid it was found that the filter soon became clogged and showed a marked reduction in bacterial efficiency, although the settling alone removed very few of the bacteria. Settling basins may therefore be considered as essential when the water is very turbid. No trouble appeared from the presence of crude petroleum or mine drainage on the water.

The mechanical filters were also given careful tests, and under certain conditions gave excellent results, but it was found that the use of a coagulant, such as sulphate of alumina was necessary, in order to insure the removal of the bacteria, and when the coagulant was omitted the number of bacteria in the effluent increased rapidly. The mechanical filters produced the clearest water, but the bacterial efficiency of the sand filters was found to be the best, while the possible pollution of the water by failure to use the coagulant even for a short time, is a decided objection to the mechanical filters, so far as public health is concerned.

The report of Professor Sedgwick showed clearly that the polluted water was the principal source of the constant and excessive amount of typhoid fever in Pittsburgh, and the report of Mr. Allen Hazen upon the best method of purification, was in favor of sand filters with sedimentation basins. For a daily consumption of 75 million gallons per day, such a plant is estimated to cost a little over two million dollars, while it would cost six times as much to bring water by gravity from a pure source.

It is interesting to note that the report comes out strongly in favor of water meters, and in this connection Mr. Hazen says:

"The city is now wasting several times as much water as it uses. The experience of other cities shows that the consumption can be greatly reduced by the adoption of the meter system for the sale of water, and the cost of filtration and pumping kept within reasonable limits."

The close relation which the use of meters bears to filtration is seen in the fact that at the present time only about one-third of the amount pumped, and therefore to be filtered, is really required. With meters the proposed filtering plant will be sufficient for fifteen years; without it the plan will be outgrown before it can be built.

Engineering in Architecture.

In these days of steel buildings, electric lighting, elevators, steam heating, and innumerable other details of engineering work in building construction, the relations of the engineer to the architect are necessarily very close, and it is most interesting to find those relations very clearly presented to the architectural fraternity in the form of a paper read before the American Institute of Architects, by Mr. H. G. Bradlee.

After referring to the gradual increase of engineering work in connection with building construction, Mr. Bradlee defines the function of the architect as the art of building beautifully, while that of the engineer is that of securing economy of construction and operation. While these two functions are, and always must be, closely related, it is practically impossible that they should both be mastered by one and the

same individual, and even if they were each would be a detriment to the other. Consultation and unity of purpose should undoubtedly exist between both branches, but it is now impossible for the architect himself to be the sole designer of all that goes into the modern building.

"The architect of a modern building, if he is to design it complete in all its details, must therefore be an engineer, and must be familiar with mechanical, electrical, and sanitary engineering in all its branches. Each of these departments of engineering has, however, grown to such an extent that a thorough knowledge of its details can only be acquired by years of study and experience, and what is perhaps more important, they are at present in a state of rapid growth. New methods and new appliances are constantly introduced, so that the best work of ten years ago is considered very inferior to-day."

As engineering work began to creep into architecture it was at first relegated to the contractor, and even to-day many architects expect to receive, and do receive much aid and advice upon matters connected with structural metal work from the engineers of the manufacturers of the material used. Gradually the employment of the consulting engineer has become more common, and the causes which in the past separated the architect from the builder are now at work separating the engineer from the engineering contractor.

At the present time, however, there is no definite practice as regards the employment of the engineer, and Mr. Bradlee suggests that the true relation is to make the engineer the assistant of the architect employed by him, and responsible to him, and not to the owner direct. The engineer is responsible for the design of the building equipment and for the results obtained from its operation, and should be given every opportunity to design the work in the manner which he considers best. The equipment, however, is subordinate to the building itself, and in most cases it is easier to make changes in the engineering work than in the construction of the building. The engineer should therefore be under the direction of the architect, and should be prepared to modify his work to any extent which may be necessary.

Masonry Construction.

NOTWITHSTANDING the great development in the application of structural steel, both for architectural and engineering work, there is undoubtedly a strong revival in favor of genuine masonry construction, and it is interesting to note that a valuable paper upon the use of masonry should have been presented before the Western Society of Engineers by Mr. George S. Morison, who has been identified in such an eminent manner with structural works in metal.

Mr. Morison divides the materials of construction into two classes, the lower and the higher, placing in the former earth and stone, and in the latter, metals and timber. The lower class possesses the great advantage of imperishability, while the higher class has the property of great adaptability. Both are eminently useful, but masonry is the only permanent form of construction available for works of a monumental character, capable of transmitting the work of one epoch to another.

Mr. Morison includes in his paper a brief historical review, showing the intelligent and artistic manner in which ancient constructors made use of masonry, and remarks that much of the old work which is generally assumed to be entirely of stone is really largely of concrete. The Roman builders used brick or stone for facing with a rubble filling which contained such a large proportion of mortar that it was really a concrete, and the excellent character of the mortar caused such structures to be as enduring as if they had been made of solid stone.

Coming down to modern times Mr. Morison shows that even with structures which are largely of iron and steel there are portions for which masonry is especially adapted. It is an absolutely appropriate material for use as a support to carry weight, as in a column or bridge pier, and the same beautiful and satisfactory results as were obtained by the Egyptians and Greeks in architecture are possible to-day in such constructions as the piers of bridges.

Again, for moderate spans, up to 150 or even 200 feet, masonry arches are most appropriate, and in this connection Mr. Morison gives in such clear language the fundamental principles of equilibrium in the arch

that we cannot refrain from quoting them entire:

"A loose cord fastened securely at each end has some form of stability for every loading which can be put upon it, the cord, however, always being in tension. If this curve, which is stable for a particular loading, and no other, is inverted, it is stable for the same loading but is in compression and not in tension; but though the cord in tension, by changing its shape for every change in loading preserves its stability, the inverted catenary would go to pieces with a very slight change in load.

"A masonry arch should act only in compression, and the strains in it are those existing in the inverted catenary. For every form of arch there is some loading that will correspond exactly to its shape. So long as the curve of strain does not pass outside of the middle third of the arch, the arch is perfectly stable and no tension occurs anywhere in the masonry. The masonry of an arch should be so laid that the joints are everywhere normal to the curve of strain, this being the direction in which the pressure acts."

Mr. Morison gives some excellent examples of the influence which proportion has upon beauty in masonry structures, and referring to the fact that art in such work is really the expression of truth in construction, he concludes:

"The construction of such masonry may not be the work of an engineer, but it must be the work of a man educated like an engineer, and who knows how to direct the great powers of nature, if not to the uses and conveniences, at least to the monumental graces of man."

Brick-Making in the United States.

BRICK is probably one of the very oldest materials of construction, but its use has never gone out of fashion, and it is today more largely employed than ever. Few people realize the enormous quantity of clay which is dug and worked into bricks in the United States, and for this reason the paper of Mr. C. C. Jones, presented before the recent meeting of the American Institute of Mining Engineers, is of interest, although it deals only with the working of the clay deposits of the lower valley of the Hudson.

Mr. Jones reports upon a careful geologic and economic survey of these clay deposits, the survey including a large number of borings for the determination of the depth of the deposits, the resulting data enabling very complete maps and sections to be made. The report gives some interesting experiences in connection with the conduct of such borings, showing also the care with which they were made.

Four principal localities were included in the survey, showing a total of about 35 million cubic yards of clay available, corresponding to very nearly 30,000 million bricks. Adding to this the probable capacity of other localities in the lower Hudson valley, it is estimated that the present output of more than 900 million bricks per year can be maintained for a period of about 60 years.

This seems like a large supply for at least two generations to come, but Mr. Jones very pertinently asks if we can expect the demand to remain uniform.

"What will be the effect of increased consumption in a rapidly expanding community, now demanding nearly one billion bricks per year, and imperatively requiring a progressively larger supply for fire-proof construction, and taller buildings, with thicker walls, and deeper foundations? What will be the duration of the supply under such demands? Unfortunately, it is not possible to command accurate comparative statistics, even for past periods. The collection of the data of brick manufacture is too recent an enterprise of the United States Geological Survey. A precise numerical forecast is, therefore, impossible at present; but a rough comparison may be made. Aside from an apparent increase in demand of 110 million bricks per annum from 1894 to 1896, and an apparently indicated increase of 25 million per annum in the ten years previous, the one known fact is a present production of practically one billion bricks by the State of New York, which is practically consumed by the city of New York. Economical investigations indicate a supply of practically one billion bricks per year for a period of 60 years. If the demand should rise to double that quantity, the question of supply would acquire an intense practical importance. Who can predict the answer?

THE ENGINEERING INDEX

INTRODUCTORY.

The object of this Index is to supply all persons interested in engineering and industrial pursuits with, first, an expert descriptive summary clearly indicating the character and purpose of the leading articles published currently in the established technical journals of the United States, Great Britain, and the Continent—in all languages; and, secondly, an inexpensive means of readily obtaining such portions of this literature as may be desired.

We hold ourselves ready to supply—usually by return of post—the full text of every article indexed, *in the original language;* and our charge in each case is regulated by the cost of a single copy of the journal in which the article is published. The price of each article is indicated by the letter following the number. When no letter appears, the price of the article is 20c. The letter A, B, or C denotes a price of 40 cts.; D, of 60 cts.; E, of 80 cts.; F, of $1.00; G, of $1.20; and H, of $1.60. In ordering, care should be taken to *give the number* of the article desired, not the title alone.

Serial publications are indexed on the appearance of the first installment.

SPECIAL NOTICE.—To avoid the inconvenience of letter-writing and small remittances, especially from foreign countries, and to cheapen the cost of articles to those who order frequently, we sell coupons at the following prices:—20c. each, or twelve for $2.00, thirty-three for $5, and one hundred for $15.

Each coupon will be received by us in payment for any 20-cent article catalogued in the Index. For articles of a higher price, one of these coupons will be received for each 20 cents: thus, a 40-cent article will require two coupons; a 60-cent article, three coupons; and so on. The use of these coupons is strongly commended to our readers. They not only reduce the cost of articles 25 per cent. (from 20c. to 15c.), but they need only a trial to demonstrate their very great convenience—especially to engineers in foreign countries, or away from libraries and technical club facilities.

Write for a sample coupon—free to any part of the world.

CARD INDEX.—These pages are issued separately from the Magazine, printed on one side of the paper only, and in this form they meet the exact requirements of those who desire to clip the items for card-index purposes. Thus printed they are supplied to regular subscribers of THE ENGINEERING MAGAZINE at 10c. per month, or $1.00 a year; to non-subscribers, 25c. per month, or $3.00 a year.

THE PUBLICATIONS REGULARLY REVIEWED AND INDEXED.

The titles and addresses of the journals regularly reviewed are given here in full, but only abbreviated titles are used in the Index. In the list below, *w* indicates a weekly publication, *b-w*, a bi-weekly, *s-w*, a semi-weekly, *m*, a monthly, *b-m*, a bi-monthly, *qr*, a quarterly, *s-q*, semi-quarterly, etc. Other abbreviations used in the Index are: Ill—Illustrated; W—Words; Anon—Anonymous.

American Architect. *w.* Boston, Mass.
American Electrician. *m.* New York.
Am. Engineer and Railroad Journal. *m.* New York.
American Gas Light Journal. *w.* New York.
American Geologist. *m.* Minneapolis, Minn.
American Journal of Science. *m.* New Haven Conn.
American Journal of Sociology. *b-m.* Chicago, Ill.
American Machinist. *w.* New York.
Am. Manufacturer and Iron World. *w.* Pittsburg, Pa.
American Shipbuilder. *w.* New York.
Am. Soc. of Irrigation Engineers. *qr.* Denver, Col.
Annals of Am. Acad. of Pol. and Soc. Sci. *b-m.* Phila.
Annales des Ponts et Chaussées. *m.* Paris.
Ann. della Societa d. Ing. e d. Arch. Ital. Rome. *b-m.*
Architect. *w.* London.
Architectural Record. *q.* New York.
Architectural Review. *s-q.* Boston, Mass.
Architecture and Building. *w.* New York.
Architektonische Rundschau. *m.* Stuttgart.
Atlantic Monthly. *m.* New York.
Australian Mining Standard. *w.* Sydney.
Automotor and Horseless Vehicle Jour. *m.* London.
Bankers' Magazine. *m.* New York.
Bankers' Magazine. *m.* London.
Bankers' Magazine of Australia. *m.* Melbourne.
Berg-und Hüttenmännische Zeitung. *w.* Berlin.
Board of Trade Journal. *m.* London.
Boston Journal of Commerce. *w.* Boston, Mass.
Bradstreet's. *w.* New York.
Brick Builder. *m.* Boston, Mass.
British Architect. *w.* London.
Builder. *w.* London.
Bulletin Am. Iron and Steel Asso. *w.* Phila., Pa.
Bulletin of Bureau of Am. Republics. *m.* Washington.
Bulletin de la Société d'Encouragement. *m.* Paris.
Bulletin of Dept. of Labor. *b-m.* Washington, D. C.
Bulletin of the Univ. of Wisconsin, Madison, Wis.
Bull. Int. Railway Congress. *m.* Brussels.
California Architect. *m.* San Francisco, Cal.
Canadian Architect. *m.* Toronto, Ont.
Canadian Electrical News. *m.* Toronto, Ont.
Canadian Engineer. *m.* Montreal, P. Q.
Canadian Mining Review. *m.* Ottawa, Ont.
Century Magazine. *m.* New York.
Chautauquan. *m.* Meadville, Pa.
Chem. Met. Soc. of S. Africa. *m.* Johannesburg, S. A. R.
Colliery Guardian. *w.* London.
Commerce. *w.* London.
Compressed Air. *m.* New York.
Comptes Rendus de l'Acad. des Sciences. *w.* Paris.
Consular Reports. *m.* Washington, D. C.
Contemporary Review. *m.* London.
Cosmopolitan. *m.* Irvington, New York.
Deutsche Bauzeitung. *b-w.* Berlin.
Dingler's Polytechnisches Journal. *w.* Stuttgart.
Domestic Engineering. *m.* Chicago, Ill.

Eclairage Electrique. *w.* Paris.
Electrical Engineer. *w.* London.
Electrical Engineering. *m.* Chicago, Ill.
Electrical Review. *w.* London.
Electrical Review. *w.* New York.
Electrical World. *w.* New York.
Electrician. *w.* London.
Electricien. *w.* Paris.
Electricity. *w.* London.
Electricity. *w.* New York.
Elektrochemische Rundschau. *b-m.* Frankfurt.
Elektrochemische Zeitschrift. *m.* Berlin.
Elektrotechnisches Echo. *w.* Magdeburg.
Electrotechniker. *b-m.* Vienna.
Elektrotechnischer Anzeiger. *s-w.* Berlin.
Elektrotechnische Zeitschrift. *w.* Berlin.
Elettricita, *w.* Milan.
Engineer. *w.* London.
Engineer. *s-m.* Cleveland, O.
Engineers' Gazette. *m.* London.
Engineering. *w.* London.
Engineering Assn. of the South. Nashville, Tenn.
Engineering and Mining Journal. *w.* New York.
Engineering Journal. *s. an.* Stanford Univ., Cal.
Engineering Magazine. *m.* New York & London.
Engineering News. *w.* New York.
Engineering Record. *w.* New York.
Eng. Soc. of the School of Prac. Sci. Toronto, Ont.
Eng. Soc. of Western Penn'a. *m.* Pittsburg, Pa.
Fire and Water. *w.* New York.
Forester. *m.* Washington, D. C.
Forum. *m.* New York.
Foundry. *m.* Detroit, Mich.
Gas Engineers' Mag. *m.* Birmingham, England.
Gas World. *w.* London.
Génie Civil. *w.* Paris.
Gesundheits-Ingenieur. *s-m.* München.
Giorn. Dei Lav. Pubb. e d. Str. Ferr. *w.* Rome.
Glaser's Ann. f. Gewerbe & Bauwesen. *s-m.* Berlin.
Gunton's Magazine. *m.* New York.
Harper's Weekly. *w.* New York.
Heating and Ventilating. *m.* New York.
Ice and Refrigeration. *m.* New York.
Ill. Carpenter and Builder. *w.* London.
Illinois Soc. of Engs. and Surveyors. Peoria, Ill.
India Rubber World. *m.* New York.
Indian and Eastern Engineer. *w.* Calcutta.
Indian Engineering. *w.* Calcutta.
Industries and Iron. *w.* London.
Inland Architect. *m.* Chicago, Ill.
Iron Age. *w.* New York.
Iron and Coal Trades Review. *w.* London.
Iron & Steel Trades Journal. *w.* London.
Iron Trade Review. *w.* Cleveland.
Jour. Am. Soc. Naval Engineers. *qr.* Wash., D. C.
Journal Assn. Eng. Societies. *m.* Phila., Pa.
Journal of Electricity. *m* San Francisco, Cal.
Journal Franklin Institute. *m.* Philadelphia, Pa.
Journal of Gas Lighting. *w.* London.
Jour. N. E. Waterw. Assoc. *qr.* New London, Conn.
Journal Political Economy. *qr.* Chicago, Ill.
Journal Royal Inst. of Brit. Arch. *s-qr.* London.
Journal of Sanitary Institute. *qr.* London.
Journal of the Society of Arts. *w.* London.
Journal of U. S. Artillery. *b-m.* Fort Monroe, Va.
Journal Western Soc. of Eng. *b-m.* Chicago, Ill.
Kansas University Quarterly. *qr.* Lawrence, Kans.
La Ingenieria. *m.* Buenos Aires, Argentina.
L'Energie Electrique. *w.* Paris.
Locomotive. *m.* Hartford, Conn.
Locomotive Engineering. *m.* New York.
Locomotive Firemen's Mag. *m.* Peoria, Ill.
Machinery. *m.* London.
Machinery. *m.* New York.
Manufacturer's Record. *w.* Baltimore, Md.
Marine Engineer. *m.* London.
Marine Engineering. *m.* New York.
Marine Review. *w.* Cleveland, O.
Master Steam Fitter. *m.* Chicago, Ill.
Mechanical World. *w.* London.
Mechanical Engineer. *w.* Manchester.
Mem. de la Soc. des Ing. Civils de France. *m.* Paris.
McClure's Magazine. *m.* New York.
Metal Worker. *w.* New York.
Mines and Minerals. *m.* Scranton, Pa.
Mining and Sci. Press. *w.* San Francisco, Cal.
Mining Journal. *w.* London.
Mining Reporter. *w.* Denver, Col.
Mitt. aus d. Kgl. Tech. Versuchsanst. Berlin.
Mittheilungen des Vereines für die Förderung des Local- und Strassenbahnwesens. *m.* Vienna.
Modern Machinery. *m.* Chicago, I .
Moniteur des Architectes. *m.* Paris.
Moniteur Industriel. *w.* Paris.
Municipal Affairs. *qr.* New York.
Municipal Engineering. *m.* Indianapolis, Ind.
National Builder. *m.* Chicago, Ill.
Nature. *w.* London.
Nature. *w.* Paris.
New Zealand Mines Record. *m.* Wellington, N. Z.
Nineteenth Century. *m.* London.
North American Review. *m.* New York.
Oest. Monatsschr. f. d. Oeff. Baudienst. *m.* Vienna.
Oest. Zeitschr. f. Berg- & Hüttenwesen *w.* Vienna.
Physical Review. *b-m.* New York.
Plumber and Decorator. *m.* London.
Popular Science Monthly. *m.* New York.
Power. *m.* New York.
Practical Engineer. *w.* London.
Pro. Am. Soc. Civil Engineers. *m.* New York.
Proceedings Engineers' Club. *qr.* Phila., Pa.
Proceedings of Central Railway Club.
Pro. of Purdue Soc. of C. E. *yr.* La Fayette, Ind.
Progressive Age. *s-m.* New York.
Railroad Car Journal. *m.* New York.
Railroad Gazette. *w.* New York.
Railway Age. *w.* Chicago, Ill.
Railway Magazine. *m.* New York.
Railway Master Mechanic. *m.* Chicago, Ill.
Railway & Engineering Review. *w.* Chicago, Ill.
Railway World. *m.* London.
Review of Reviews. *m.* New York.
Revista de Obras Publicas. *w.* Madrid.
Revue de Mécanique. *m.* Paris.
Revue Gen. des Chemins de Fer. *m.* Paris.
Revue Technique. *b-m.* Paris.
Revue Universelle des Mines. *m.* Liége.
Rivista Marittima. *m.* Rome.
Sanitarian. *m.* Brooklyn, N. Y.
Sanitary Plumber. *s-m.* New York.
Sanitary Record. *m.* London.
School of Mines Quarterly. New York.
Schweizerische Bauzeitung. *w.* zürich
Science. *w.* Lancaster, Pa.
Scientific American. *w.* New York.
Scientific Am. Supplement. *w.* New York.
Scribner's Magazine. *m.* New York.
Seaboard. *w.* New York.
Sibley Journal of Eng. *m.* Ithaca, N. Y.
Southern Architect. *m.* Atlanta, Ga.
Stahl und Eisen. *s-m.* Düsseldorf.
State's Duty. *m.* St. Louis, Mo.
Steamship. *m.* Leith, Scotland.
Stevens' Indicator. *qr.* Hoboken, N. J.
Stone. *m.* Chicago. Ill.
Street Railway Journal. *m.* New York.
Street Railway Review. *m.* Chicago, Ill.
Technology Quarterly. Boston, Mass.
Technograph. *yr.* Champaign, Ill.
Terrestrial Magnetism. *qr.* Cincinnati, O.
The House Beautiful. *m.* Chicago, Ill.
Trans. Assn. C. E. of Cornell Univ. Ithaca, N. Y.
Trans. Am. Ins. Electrical Eng. *m.* New York.
Trans. Am. Ins. of Mining Eng. New York.
Trans. Am. Soc. of Civil Engineers. *m.* New York.
Trans. Am. Soc. of Heat. & Ven. Engrs. New York.
Trans. Am. Soc. Mech. Engineers. New York.
Transport. *w.* London.
Western Electrician. *w.* Chicago, Ill.
Western Railway Club Pro. Chicago, Ill.
Wiener Bauindustrie Zeitung. *w.* Vienna.
Wisconsin Engineer. *qr.* Madison. Wis.
Yale Scientific Monthly. *m.* New Haven, Conn.
Year Book of Soc. of Engs. Univ. of Minn.
Zeitschrift für Locomotivführer *m.* Hannover.
Zeitschrift f. Maschinenbau & Schlosserei. *m.* Berlin.
Zeitschr. d. Oest. Ing. u. Arch. Ver. *w.* Vienna.
Zeitschr. d. Ver. Deutcher Ingen. *w.* Berlin.
Zeitschrift für Elektrochemie. *s-m.* Halle a. S.
Zeitschrift für Elektrotechnik. *s-m.* Halle a. S.

ARCHITECTURE AND BUILDING

CONSTRUCTION AND DESIGN.

Ashlar.

The Face-Bonding of Broken Ashlar. Clarence A. Martin. Suggestions in drawing, building and inspecting certain kinds of stone walls, giving some of the principles that have governed the best work. 900 w. Am Arch—Feb. 11, 1899. No. 25887.

Churches.

Church Architecture in Materials of Clay. Thomas Cusack. Discusses the artistic work and enduring qualities of these materials, and describes some excellent English work in structural terra-cotta, referring also to its extensive use from the twelfth to the sixteenth century in Italy. Ill. 2200 w. Br Build—Jan., 1899. No. 25607 C.

The History of the Frederick Church at Copenhagen. (Die Entstehungsgeschichte der Frederikskirche zu Kopenhagen.) An account of this old Danish church, with reproductions of the original designs of Eigtved and Jardin. 2500 w. 2 plates. Oesterr Monatschr f d Oeffent Baudienst—Feb., 1899. No. 26049 D.

Clock Faces.

Architectural Treatment of Clock Faces. Illustrates and describes successful treatment of this feature of public buildings. 1600 w. Builder—Feb. 11, 1899. No. 26102 A.

Competitions.

General Code Governing Competitions in Design. The text of the General Code adopted by the Architectural League of New York, the National Sculpture Society, and the National Society of Mural Painters, with editorial. 2000 w. Arch & Build—Feb. 4, 1899. No. 25756.

Design.

Common Errors in Architectural Design. Frank Baggallay. Read before the Sheffield Soc. of Arch'ts. and Surv. Considers the use and misuse of ornament; its quality, etc.; the wrong treatment of material; bad proportion; errors in planning and other faults. 9000 w. Builder—Jan. 21, 1899. No. 25656 A.

Exposition.

The Present Condition of the Work at the Champ-de-Mars. (Etat Actuel des Travaux du Champ-de-Mars.) A description of the progress of the work upon the main buildings of the Paris Exposition of 1900, with plan of grounds. 1200 w. Le Génie Civil—Jan. 21, 1899. No. 26003 D.

Fireproofing.

Fireproofing Material. Considers that the proper handling of steel or iron for fireproofing, requires that it be surrounded with concrete so as to leave no air space, and discusses the proper kind of concrete to be used. Ill. 1600 w. Fire & Water—Feb. 18, 1899. No. 26140.

Lessons from the Home Life Building Fire. Thomas Cusack. Presents the opinions of architects on the weather and fire-resisting qualities of terra-cotta as compared with marble, granite, limestone or sandstone. 1100 w. Br Build—Jan. 1899. No. 25609 C.

The Teachings of the New York Fire. Quotes from editorials and articles in the New York papers upon the fire effects on the Home Life Insurance Building, commenting on their justness and intelligence. 3000 w. Br Build—Jan., 1899. No. 25608 C.

Flats.

On London and Paris Flats. Gaspard Tournier. The disposition of apartments in Paris flats is criticized, and illustrations given of London apartment houses. 1000 w. Brit Arch—Feb. 3, 1899. No. 25895 A.

Greek Architecture.

Greek Architecture. George Aitchison. First Royal Academy lecture. The simplicity of this style, the care taken to design for sunshine, and the climate of Greece, which often renders their mouldings ineffective in moist, sunless climates. The conditions existing in Greece and England are compared, and an interesting study commenced. 5400 w. Builder—Feb. 4, 1899. Serial. 1st part. No. 25902 A.

Greenhouses.

Building a Glass-house. On the construction of greenhouses of various kinds, and the points to be especially considered. 2000 w. Ill. Car & Build—Feb. 3, 1899. No. 25893 A.

Hollow Blocks.

Hollow Block Building vs. Frame. M. W. Lauer. The writer believes a hollow-block house far ahead of frame from all points of argument; but regrets the limits of the material as now manufactured, the range of molds making it impossible to carry out the architect's designs. 1700 w. Brick—Feb. ,1899. No. 25708.

Natural Forms.

Nature's Cathedrals. M. H. McDowell. On the decorations and architectural designs taken from nature, especially from the caves and caverns of the under-world. Ill. Am Arch—Feb. 11, 1899. Serial. 1st part. No. 25886.

Parliament House.

The New Parliament Buildings at Budapest. (Das Neue Parlamentsbebäude in Budapest.) A fully illustrated account of the rather ornate structure recently completed at Budapest for the Hungarian Parliament. 3 articles. 3000 w. Schweizerische Bauzeitung—Jan. 7, 14, 21, 1899. No. 26058 each B.

Public Buildings.

The State, War, and Navy Department Building, Washington. G. W. Baird. Illustrates and describes the mechanical features of an office-building covering an area of 565 x 342 feet, and costing $10,300,000. 3000 w. Eng Rec—Feb. 18, 1899. No. 26119.

Reconstruction.

Reconstruction of the Home Insurance Building, N. Y. Illustrated description of the methods employed in reconstructing portions of a high office building damaged by fire. 2000 w. Eng Rec—Feb. 11, 1899. No. 25843.

Steel Construction.

The Standard Building, New York City. Illustrated description of the method followed in building around and over a large office structure in New York, with details of the steel work. 3000 w. Eng Rec—Feb. 25, 1899. No. 26187.

Theatre.

The Construction of the Imperial Jubilee Theatre in Vienna. (Ueber deu Bau des Kaiser-Jubiläums-Stadttheaters in Wien.) Franz Freiherrn v. Krauss. A very full account of this fine new theatre building, with plans and sections. Especial care has been given to the lighting and ventilation. 3500 w. Zeitschr d Oesterr Ing u Arch Ver—Jan. 20, 1899. No. 26053 B.

Trusses.

Experiments on Full-Sized Timber Trusses. G. K. Scott-Moncrieff. The object of the experiments described was to ascertain whether trusses, as constructed according to English practice, had any advantage over others designed more in accordance with theory, and more economical in material. Ill. 3000 w. Jour of Roy Inst of Brit Archt's—Jan. 14, 1899. No. 25836 B.

HEATING AND VENTILATION.

County Buildings.

Heating of County Buildings, Mason City, Iowa. Illustrated description of a plant for independent buildings exposed to very cold weather. 800 w. Eng Rec—Feb. 4, 1899. No. 25752.

Greenhouse.

Heating the Greenhouse. On the hot-water system and its adaptability to plant growth. 1000 w. Ill Car & Build—Feb. 3, 1899. No. 25894 A.

Low Pressure.

The Advantages of Steam Heating at or Below Atmospheric Pressure. M. O. Kasson. Part of a paper read before the Architects' Club of Chicago. Considers steam circulated by air pressure, explaining the merits, and the methods employed. 2700 w. Met Work—Feb. 18, 1899. No. 25957.

Mechanical Plant.

Heating and Lighting of the University Block, Syracuse, N. Y. Illustrated description of the plant of an 11-story office building, for heating and lighting service. 3500 w. Eng Rec—Feb. 25, 1899. No. 26189.

Residence.

Heating a Private Residence with a Warm Air Furnace. B. Harold Carpenter. Illustrates and describes the arrangement adopted in city residences, which has given satisfactory results. 1000 w. Dom Engag—Feb., 1899. No. 26165 C.

School.

Plenum Ventilation in its Application to Public Elementary Schools. S. Barwise. Shows the necessity of mechanical ventilation, and discusses the exhaust system as well as the plenum. Discussion. 5600 w. Jour of San Inst—Jan., 1899. No. 25781 F.

Shop Heating.

Ventilation and Heating of a Railroad Shop. Illustrated description of the plant by which a number of large detached shops are heated by an air supply from a single source. 1400 w. Eng Rec—Feb. 18, 1899. No. 26123.

Ventilation.

Necessity of Ventilation. H. Eisert. Presented at meeting of American Soc. of Heating and Ventilating Engs. Shows the necessity of constantly renewing the air, the changes wrought by respiration, combustion, etc. 3000 w. Pro Age—Feb. 15, 1899. No. 25944.

PLUMBING AND GASFITTING.

Drainage.

I. The Construction and Ventilation of House Drains. A. Bostock Hill. II. Combined Drainage. Its pros and cons. Joseph Priestley. Two sanitary papers with discussion presented at the congress at Birmingham, England. 7000 w. Jour of San Inst—Jan., 1899. No. 25777 F.

Hot-Water Supply.

Faults and Causes of Failure in Domestic Hot-Water Supply. Frederick Dye. Part first considers boilers and their effectiveness, and the position of the pipes in the common type of apparatus on the tank system. Ill. 2200 w. Plumb & Dec—Feb. 1, 1899. Serial. 1st part. No. 26106 A.

House Service.

German and English House Water-Service. (Deutsche und Englische Hausentwasserungen.) M. Knauff. A comparison between German and English methods of house plumbing, both for water supply and drainage connections, indicating the preferable methods in each case. 6000 w. Two articles. Gesundheits-Ingenieur—Jan. 31, Feb. 15, 1899.. No. 26068 each B.

Public Baths.

Public Baths and Wash Houses. A. Hessell Tiltman. Abstract of paper read before the Royal Inst. of Brit Archt's, with discussion. Deals with the requirements of such establishments. 3500 w. Builder—Feb. 11, 1899. No. 26103 A.

The Arrangement and Operation of Public Baths. (Ueber Badeeinrichtungen in Gewerblichen Betrieben.) A. Herzberg. With especial reference to douche and spray baths for workmen's and military baths. 3000 w. Gesundheits-Ingenieur—Feb. 15, 1899. No. 26079 B.

The Mueller Public Baths at Munich. Description with floor plans and elevation, of one of the most elaborate public baths constructed in modern times, covering an area of about 172-000 sq. ft. 1600 w. Eng Rec—Feb. 18, 1899. No. 26120.

MISCELLANY.

Address.

Address to Students at a Meeting of the Royal Institute of British Architects. George Aitchison. 3000 w. Builder—Jan. 28, 1899. No. 25825 A.

Building Rules.

Building Rules of Edinburgh. A copy of the regulations governing the erection of buildings in this city. 1200 w. Arch, Lond—Feb. 3, 1899. No. 25903 A.

The Supervision and Regulation of Building Operations, as exercised by the Edinburgh Dean of Guild Court. David Lyon. A brief account of the origin and nature of this Court, its present form, its jurisdiction and functions. 5400 w. Arch, Lond—Feb. 3, 1899. Serial. 1st part. No. 25904 A.

Competition.

The Californian University Competition. Report of the reception, preparation and judgment of the plans submitted in competition for the "Phoebe A. Hearst architectural plan for the University of California." 1700 w. Arch, Lond—Jan. 27, 1899. No. 25822 A.

Domestic Architecture.

The Modern Woman and Domestic Architecture. F. W. Fitz-Patrick. The writer considers woman's influence has not been for good and urges a more intelligent study of good architecture and the planning of homes. 2500 w. In Arch—Feb., 1899. No. 25935 F.

Fire Prevention.

Testing Station of the British Fire Prevention Committee. Describes a recently opened testing station for fire-resisting materials, methods of construction and appliances, with a general view of the testing chambers and generator, and a view of the instrument room. 1300 w. Engng—Feb. 3, 1899. No. 25907 A.

Fire Risks.

The Fire Risk in Fire-Proof Buildings. A review of an analysis by R. W. Gibson, of the effect of various improvements in the premium to be paid for fire insurance. 1600 w. Eng Rec—Feb. 18, 1899. No. 26121.

Form-Design.

Some Principles of Form-Design in Applied Art. Hugh Stannus. The importance of studying the characteristic qualities of material. 2500 w. In Arch—Feb., 1899. No. 25936 F.

Palestine.

Ancient and Modern Buildings in Palestine. Beresford Pite. Abstract of a lecture, delivered before the Architectural Assn., London. Reviews the architecture and the influences that affected it, with hints of use to those who design buildings for Palestine, and a list of prices of material and work. 1600 w. Arch, Lond—Jan. 27, 1899. No. 25823 A.

Rural Districts.

Some Sanitary Defects in Rural Districts with Suggestions for their Remedy. George H. Smith. Considers briefly the principal defects, such as water supply, drainage, etc., with their remedies. Discussion. 5000 w. Jour of San Inst—Jan., 1899. No. 25779 F.

Stained Glass.

Stained Glass. Christopher Whall. Abstract of lecture read before the Arch. Assn., London. Describes the various steps of the work, and offers some criticisms. Also discussion. 6300 w. Builder—Feb. 11, 1899. No. 26104 A.

CIVIL ENGINEERING

BRIDGES.

Alexandre III.

The Alexander III. Bridge Across the Seine. (Pont Alexandre III. sur la Seine.) A fully illustrated description of the construction and launching of the temporary truss to be used in connection with the erection of the main arch of the bridge. Serial. Part I. 3000 w. 1 plate. Le Genie Civil—Feb. 4, 1899. No. 26006 D.

Arch.

Inclined Arch Construction. (Die Schrägstellung der Trägerwände bei Bogenbrücken.) Karl Probst. An investigation of the construction of metal arch bridges with inclined roadways, with illustrations of recent structures in Switzerland. Two articles. 2000 w. Schweizerische Bauzeitung—Jan. 21, 28, 1899. No. 26059 each B.

Austria.

Iron Bridge Construction in Austro-Hungary. (Eiserne Brückenbauten in der Oesterreichisch-Ungarischen Monarchie.) M. Foerster. A discussion of the principles of bridge trusses, with diagrams of structures recently erected. 2500 w. Stahl und Eisen—Feb. 1, 1899. No. 26042 D.

Concrete.

A Concrete Arch Bridge with Granite Hinges. A description of the Imnau bridge condensed from an article in the Zeitschrift für Bauwesen. Ill. 1000 w. Eng News—Feb. 16, 1899. No. 25967.

The Concrete-Iron Bridge at Schloss Eichhorn in Moravia. (Beton-Eisenbrücke auf Schloss Eichhorn in Mähren.) J. Melan. A handsome concrete-iron arch bridge on the Melan principle, of about 58 feet span. 1200 w. 1 plate. Oesterr Monatschr f d Oeffent Baudienst—Feb., 1899. No. 26048 D.

Drawbridges.

A New Way of Constructing Drawbridges. Brief illustrated description of design of William L. Sampson, which consists of movable cantilever spans having inclines, and aprons adapted to be engaged by the inclines and swung into an angular position. 600 w. Sci Am—Feb. 4, 1899. No. 25694.

Düsseldorf.

The New Düsseldorf Bridge Over the Rhine. From *Ueber Land und Meer*. Brief illustrated description. 500 w. Sci Am Sup—Feb. 11, 1899. No. 25863.

Girders.

Bridge Girders, Indian State Railways. Drawings, details and particulars of spans with 6, 10, 12 and 20 feet. 250 w. Ind Engng—Jan. 14, 1899. No. 25993 D.

Review.

Notable Bridge Construction in 1898. A review of modern work of interest, the removal of historic bridges to make room for structures of greater strength and capacity, characteristics of the most typical examples of recent work, etc. 2800 w. Eng News—Feb. 2, 1899. No. 25706.

Roman Bridges.

The Bridges Over the Tiber in Ancient Rome. From *La Nature*. Description and views, given for the purpose of showing the characteristic differences from present types. 1400 w. Sci Am Sup—Feb. 18, 1899. No. 25943.

Sohan Bridge.

The erection of Sohan Bridge. Brief illustrated description of the construction of a bridge by means of fan-shaped falsework built out from the base of each pier. 450 w. Eng Rec—Feb. 4, 1899. No. 25745.

Truss Bridges.

Standard Plans for 130-ft. Through Truss Bridges; Northern Pacific Ry. Full-page plate with description of one of the bridges adopted by this road to replace the old wooden bridges. 450 w. Eng News—Feb. 2, 1899. No. 25705.

Van Buren St. Bridge.

Change of Approach Span, Van Buren St. Bridge, Chicago. An account of changes made necessary in the construction of the drainage canal, and the exacting conditions imposed upon the engineers. 900 w. Ry & Engng Rev—Feb. 18, 1899. No. 26131.

Viaduct.

The Viaduct at Drum and Neuschloss on the Northern Bohemian Transverse Railway. (Die Viaducte bei Drum und Neuschloss auf der Nordböhmischen Transversalbahn.) H. Rosche. With a view of the Korba viaduct and a plan of the country traversed. 1500 w. Zeitsch d Oesterr Ing u Arch Ver—Jan. 27, 1899. No. 26054 B.

The Viaduct of Müngsten. From *La Génie Civil*. Describes and illustrates an arched railway bridge, recently erected in Germany, having a span of 560 ft. 2500 w. Engr, Lond—Jan. 20, 1899. No. 25632 A.

Youngstown Bridge.

South Market Street Bridge, Youngstown, O. Illustrates and describes the design and erection of a bridge with a main span of 210 1-2 feet, formed of a plate girder arch, and approaches of special design. 1400 w. Eng Rec—Feb 4, 1899. No. 25748.

CANALS, RIVERS AND HARBORS.

Canal Scheme.

A Great Canadian Canal Scheme. Notes the revival of the scheme for the construction of a ship-canal to connect the St. Lawrence River with the great lakes, discussing its advantages, and the route. 1900 w. Engng—Feb. 3, 1899. No. 25905 A.

Chicago.

They By-Pass Channel for the Chicago River. Illustrated detailed description. 1800 w. Eng News—Feb. 16, 1899. No. 25968.

Dam.

The Castlewood Rock-Fill Dam and the Canal of the Denver Land & Water Co. W. P. Hardesty. Describes the system of this company, which was formed for the purpose of storing water and using it to irrigate land in the vicinity of the city. 4500 w. Eng & Min Jour—Feb. 9, 1899. No. 25855.

Dredge.

Ten-Yard Clam-Shell Dredge for the Buffalo, N. Y., Breakwater Construction. Describes and illustrates a dredge that has operated successfully under disadvantageous conditions. 1500 w. Eng News—Feb. 2, 1899. No. 25703.

Dredging.

Hydraulic Dredging in Tidal Channels. W. H. Wheeler. Describes the results and cost of works in several countries. 5000 w. Eng. Rec—Feb. 4, 1899. No. 25751.

Dry Docks.

Masonry or Wooden Dry-Docks. A review of the important light thrown on the relative advantages of timber and masonry graving docks, by the results of the competition for the new Boston structure. 1200 w. Eng Rec—Feb. 11, 1899. No. 25842.

Masonry of Wooden Dry-Docks. Brief synopses of papers by William Ledyard Cathcart and Mordecai T. Endicott, given at special meeting to discuss the relative merits, with particular reference to the needs of the U. S. Navy. 2300 w. R R Gaz—Feb. 17, 1899. No. 25948.

The Comparative Merits of Timber and Masonry Dry-Docks. Report in full of Mordecai T. Endicott, Chief of the Bureau of Yards and

Docks, respecting materials for the four new dry-docks provided for by the U. S. Congress. 1300 w. Eng News—Feb. 9, 1899. No. 25856.

The New Masonry Dry-Dock at Boston, Mass. Illustrates and describes the leading features of this structure, 788 feet long, giving the elaborate cement specifications in full. 2800 w. Eng Rec—Feb. 4, 1899. No. 25747.

Iron Pier.

Construction of the Old Orchard Pier. Illustrated description of the construction of a steel pier 1800 feet long, supported on jet-piles. 2000 w. Eng Rec—Feb. 11, 1899. No. 25844.

Manchester.

The Manchester Ship Canal. Willard S. Mattox. The influence of this canal on trade, an account of the difficulties that attended its construction, and the dock and quay equipment, and the prospect of its financial success. 2800 w. Ir Age—Feb. 2, 1899. No. 25692.

Masonry.

Masonry. George S. Morison. Briefly discusses materials used in construction, and the special suitability of masonry for works that are to endure. Gives a general outline and reviews the principles that must be followed to secure good results. Ill. 10800 w. Jour W Soc of Engs—Dec., 1898. No. 25671 D.

Nicaragua.

A Review of the Nicaragua Canal Scheme. W. Henry Hunter. A careful discussion of the proposed route, showing its difficulties and uncertainties, and calling for a most careful investigation of the scheme. 6000 w. Engineering Magazine—March, 1899. No. 26098 B.

The Hepburn Bill for a Nicaragua Canal. An editorial discussion of the "amendment" to the Senate bill. 2200 w. Eng News—Feb. 9, 1899. No. 25857.

The proposed Nicaragua Canal. An illustrated comprehensive description of this canal is given, and a comparison of its natural, commercial and political advantages with those of the Panama route. 6400 w. Sci Am—Feb. 18, 1899. No. 25930.

Panama.

A Plan for an Artificial Torrent. (Un Projet de Torrent Artificiel.) Leo Dex. A discussion of the plan of M. Bartissol to control the waters of the Chagres for use in a form of hydraulic mining in connection with the excavation of the Panama canal. 3500 w. La Revue Technique—Jan. 25, 1899. No. 26017 D.

The New Panama Canal. Discusses the present status and future prospects of this undertaking. Gives the history of the work under Ferdinand de Lesseps, and of the investigations made by the new company, the amount of work done, the cost of completion, etc. Also editorial. Ill. 4500 w. Sci Am—Feb. 4, 1899. No. 25693.

Retaining Walls.

Construction of Retaining Walls for the Sanitary District of Chicago. James W Beardsley. Illustrated detailed description of the work, with discussion. 6800 w. Jour W Soc of Engs—Dec., 1898. No. 25672 D.

River Improvement.

The Water Hyacinth. Describes the results of the government investigating board charged with finding some means of exterminating this plant, which is rapidly clogging many navigable streams in Florida and Louisana. 700 w. Eng Rec—Feb. 4, 1899. No. 25744.

Water Hyacinth Obstructions in Southern Rivers. Reviews the results of the experiments and investigations conducted by the Board appointed by the government. 1400 w. Naut Gaz—Feb. 2, 1899. No. 25765.

Sault Ste. Marie.

Sault Ste. Marie Canal. Views of the old state lock, with a historical resume of the development of the canal. 800 w. Marine Rev—Feb. 23, 1899. No. 26201.

Sea Encroachment.

Sea Encroachment and Case Groynes. Illustrates and describes the groyne invented and patented by Edward Case. The object is to utilize the destructive forces of the sea for constructive purposes. 2000 w. Engng—Jan. 27, 1899. No. 25793 A.

Sluice Recorder.

Automatic Sluice Recorder for the Manchester Ship Canal. A. J. Mentha. Description with drawings of the instrument for ascertaining the quantity of water flowing into or from the canal. Also describes the installation. 1500 w. Prac Eng—Jan. 27, 1899. Serial. 1st part. No. 25826 A.

IRRIGATION.

Economy.

The Conservation of Soil Moisture and Economy in the Use of Irrigation Water. E. W. Hilgard and R. H. Loughridge. Considers the amount of water required by crops, the most economical mode of using irrigation water, and the conservation of the moisture imparted to the soil. 3200 w. Ind Forester—Dec., 1898. No. 25681 D.

Reservoir.

Harnessing the Nile. Frederic Courtland Penfield. An account of the gigantic engineering undertaking, which will create a large lake in the desert of Africa, and control it so that the water may be turned into distant channels at will. Ill. 3500 w. Century Mag—Feb., 1899. No. 25600 D.

MISCELLANY.

Cement.

Cement Specifications and Cement Testing. Robert W. Lesley. Abstract of an interesting paper recently read before the Engs' Club of Phila. on the wide divergence between specifications for the same material for the same purposes, with hints for standardizing, with specifications and tests. Ill. 3700 w. Eng Rec—Feb. 25, 1899. No. 26188.

Russian Portland Cement Specifications. These are noteworthy for prescribing two sets of tests, one for the laboratory on the work, and the other for the more careful investigations possible in the laboratories of expert testing establishments. 2800 w. Eng Rec—Feb. 18, 1899. No. 26118.

Specifications for Cement. A copy of the specifications for testing cement, based on actual tests, issued by the Cement Users Testing Assn., of London. 1400 w. Arch & Build—Feb. 4, 1899. No. 25757.

The Plant of the Michigan Portland Cement Company, Coldwater, Mich. Frederick H. Lewis. Illustrated description of a plant of 4,000 bbls. daily capacity, using wet processes and rotary kilns. 1500 w. Eng Rec—Feb. 25, 1899. No. 26185.

Cement Mortar.

Ingredients of a Cubic Yard of Cement Mortar and the Cost. L. C. Sabin. Discusses methods of obtaining approximate results, giving tables with explanation of their use. 1100 w. Munic Engng—Feb., 1899. No. 25678 C.

Concrete.

Some Recent Tests of Concrete Cubes. W. A. Rogers. An account of experiments made in connection with tests of cement furnished for the work on the elevation of tracks in Chicago. 2000 w. Ry & Engng Rev—Feb. 18, 1899. No. 26133.

The Influence of Imbedded Metal on the Properties of Mortar and Concrete. (Influence des Armatures Métalliques sur les Propriétés des Mortiers et Bétons.) A general discussion, by Chief Engineer Considére, of the behavior of structures of metal and concrete, based upon experiments by the department of Ponts et Chaussées. Serial. Part I. 3000 w. Le Génie Civil—Feb. 4, 1899. No. 26007 D.

The Proportions of Concrete. A paper giving methods of estimating the relative proportions of cement needed for varying proportions and sizes of sand and stone. 1200 w. Eng Rec—Feb. 11, 1899. No. 25848.

Earthwork.

The Measurement of Earthwork. In view of the different results obtained when earthwork is measured in different ways, the courts in the various states are sometimes called upon to establish one method as standard. The Supreme Court of California has recently fixed such a standard in a case reviewed under this title. 1000 w. Eng Rec—Feb. 4, 1899. No. 25743.

Road.

Mr. Alfred Holt's Plateway Scheme for Heavy Traffic. Illustrates and describes this system, stating its merits. 2200 w. Automotor Jour—Jan., 1899. No. 25642 A.

New Jersey Roads. A review of the methods of building and repairing state roads. 1400 w. Eng Rec—Feb. 25, 1899. No. 26183.

Surveying.

A Stadia Diagram. Morris K. Trumbull. Gives a stadia diagram designed with a view to lessening the time required for the reduction of the notes, with a brief description of the methods used in its construction. 4400 w. Jour W Soc of Engs—Dec., 1898. No. 25675 D.

ECONOMICS AND INDUSTRY

COMMERCE AND TRADE.

Agricultural Machinery.

Agricultural Machinery in Germany. Prepared by the Philadelphia Commercial Museum. American trade in this line shows an advance of over 50 per cent. in ten years. Information concerning the machines most widely used. 2000 w. Am Mfr & Ir Wld—Feb. 3, 1899. No. 25790.

Bicycles.

American Bicyles and Vehicles in England. Extracts from the annual report of Consul Halstead, of Birmingham, concerning the bicycle business. Discusses the condition of the market in England, the status of the English manufacturer, etc. 4000 w. U S Cons Repts, Vol LIX—Feb., 1899. No. 25661 D.

Brazil.

American Trade in Brazil. C. Paulo Rei. An article objecting to a statement made, that this is not a favorable time for the increase of American trade, and explaining the present conditions. 2000 w. Ir Age—Feb. 16, 1899. No. 25933.

British Commerce.

Exports and Imports. A resume and editorial discussion of a paper by Sir Robert Giffen read at a meeting of the Royal Statistical Society. A clear and complete contribution to the problem of national economics, showing that international trade means more than the buying and selling of goods, and that the subject in its entirety presents a different aspect. 2300 w. Engng—Jan. 20, 1899. No. 25614 A.

The Excess of Imports. Sir Robert Giffen. A summary of the principal statements and conclusions of a paper read before the Royal Statistical Society. 2500 w. Col Guard—Jan. 20, 1899 No. 25625 A.

British Trade.

British Trade in South America. Extracts from reports by Mr. Worthington, special commissioner to investigate the condition of British trade in certain South American countries. Report concerning Chile. 9600 w. U S Cons Repts, No. 341—Feb. 3, 1899. No. 25659 D.

Excess of Imports in British Trade. Comment on some points in the paper read by Sir Robert Giffen before the Royal Statistical Society. 1000 w. Bradstreet's—Feb. 4, 1899. No. 25758.

China.

United States Trade at Chefoo. Tabulated statements of imports with information of interest to American exporters. 1800 w. U S Cons Repts, No. 348—Feb. 11, 1899. No. 25880 D.

Coal Syndicate.

The Rhenish-Westphalian Coal Syndicate. George Blake Walker. Abstract of paper read at meeting of the Midland Inst. of Min., Civil and Mech. Engs. with discussion. Reports the continued success of this combination, and the conditions affecting it. 2200 w. Col Guard—Feb. 3, 1899. No. 25914 A.

The Rhenish-Westphalian Fuel Syndicates. Brief summary of information concerning these combinations which have so largely contributed to the prosperity of the German coal trade. 1200 w. Col Guard—Jan. 20, 1899. No. 25619 A.

Combinations.

Industrial Combinations. Discusses the remarkable number of corporations, and the danger. 900 w. Bradstreet's—Feb. 18, 1899. No. 25954.

Competition.

America and Germany as Export Competitors and Customers. Louis J. Magee. Giving especially a view of the economic legislation of Germany and the influence which it has exerted upon trade. 3000 w. Engineering Magazine—March, 1899. No. 26091 B.

American Competition in the German Iron Market. Jacob Muench. An account of the German iron industry and a discussion of the possibilities of foreign competition. 1500 w. Ir Trd Rev—Feb. 2, 1899. Serial. 1st part. No. 25717.

Egypt.

Egypt's Promising Market for American Goods. Prepared by the Phila. Commercial Museum. On the promising outlook in this market. 1800 w. Am Mfr & Ir Wld—Feb. 10, 1899. No. 25891.

Far East.

A Japanese View of Far Eastern Affairs. Editorial review of a treatise prepared by Mr. Nakao Komanosuke. Notes some of the interesting points, especially in relation to Japan's future policy and its influence on the industry and trade. 7000 w. Engng—Jan. 27, 1899. No. 25795 A.

Hong Kong.

Increase of United States Trade with Hong Kong. Reports a permanent increase of trade and discusses some commercial questions of interest. 2500 w. U S Cons Repts, Vol. LIX—Feb., 1899. No. 25665 D.

Imports.

United States Imports at Bristol. Information concerning corn, barley, bacon, cattle, and iron manufacturers. 1500 w. U S Cons Repts, No. 343—Feb. 6, 1899. No. 25771 D.

Iron Trade.

Pittsburg Pig Iron in England. Clippings from British journals in regard to the shipping of 2000 tons of pig iron to Birmingham. 2000 w. U S Cons Repts, No. 346—Feb. 9, 1899. No. 25827 D.

The English Iron Market. Willard S. Mattox. On the standing of American iron in England, the reasons why orders cannot now be filled. Also reports of the English iron districts, and observations on the shipping. 1600 w. Ir Age—Feb. 16, 1899. No. 25934.

United States Iron and Tools in England. Information of interest and importance concerning trade in these products. 5200 w. U S Cons Repts, Vol. LIX—Feb., 1899. No. 25663 D.

Japan.

Why Japan Left China Behind. J. Morris. The first of a series of articles, showing the influence of engineering in opening the interior of Japan, and contrasting their achievements with

the Chinese. 1500 Ind w. & East Engr—Jan., 1899. Serial. 1st part. No. 26112 D.

Railroad Monopoly.

The Outworkings of a Railroad Monopoly. Clarence Deming. A review of the outworkings of the Consolidated Company, whose control embraces all roads but one in Connecticut, and most of southern New England, also four leading Sound boat lines. 1800 w. R R Gaz—Feb. 3, 1899. No. 25730.

Rubber Trust.

The Rubber Trust. Editorial review and articles of interest relating to the trust. 10500 w. Ind Rub Wild—Feb. 1, 1899. No. 25753 D.

South America.

United States Cotton Fabrics in South America. Urging the introduction of these products by United States manufacturers. 1200 w. U S Cons Rept, No. 329—Jan. 20, 1899. No. 25773 D.

Tariff.

Changes in Mexican Tariff. A copy of a decree of Dec. 30, 1898. 1700 w. U S Cons Repts, No. 342—Feb. 4, 1899. No. 25755 D.

Trade Extension.

Does Trade Follow the Flag? Lord Masham. A reply to an article by Lord Farrar. Favors protection for British trade. 2000 w. Contemporary Rev—Feb., 1899. No. 26199 D.

Trade Methods.

American Goods and Trade Methods in England. Concerning the attempts made to sell American paper; American wheat; factory sightseeing; pen manufacture, etc. 2500 w. U S Cons Repts, Vol. LIX—Feb., 1899. No. 25662 D.

Trade Names.

Trade Names. Cites cases showing the attitude of the Court of Chancery, England, towards those who imitate the trade names of rival firms. 2500 w. Engng—Jan. 27, 1899. No. 25797 A.

Trade Relations.

Foreign-Trade Policies. A request for information was sent out in regard to the policies adopted to extend foreign commerce. The replies are given. 18000 w. U S Cons Repts, Vol. LIX—Feb., 1899. No. 25660 D.

Some Features of Our Foreign Trade This Year and Last. A review of imports and exports of the United States, and the causes that have influenced the trade. 1200 w. Bradstreet's —Feb. 18, 1899. No. 25956.

Whom We Trade With and How. An interesting review of the United States trade for 1898, showing the value of exports and imports, and many interesting details. 1200 w. Bradstreet's—Feb. 25, 1899. No. 26195.

CURRENCY AND FINANCE.

Clearing-House.

The Clearing-House. John H. Blacklock. A paper written with the object of bringing about the organization of Clearing Houses in towns where the banks are comparatively few in number. Gives methods of operation, constitution, rules and practical working forms. 6800 w. Bankers' Mag., N. Y—Feb., 1899. No. 25882 D.

Currency Reform.

Banking and Currency Reform from a Country Standpoint. John W. Fries. Some account of banking business as conducted at present, with discussion of the system of loaning money on call, and the need of country banks having the privilege of issuing circulating notes based on their general assets. 4000 w. Bankers' Mag., N. Y—Feb., 1899. No. 25881 D.

Funds.

Reserve and Sinking Funds in Relation to Mining and Manufacturing Companies. George Johnson. Discusses what a reserve fund is, and the purposes for which it is created; its investment, and proper method of recording. And similar discussion of a sinking fund. 2800 w. Ir & Coal Trds Rev—Jan. 27, 1899. No. 25807 A.

Indian Currency.

The Indian Currency. John Lubbock. Discussion of the proposal made by the Indian Government to the Home Government, with suggestions made with a view to giving India a satisfactory currency. 4400 w. Contemporary Rev—Feb., 1899. No. 26200 D.

Investments.

The Money Centers and Tramway Opportunities of the world. A survey indicating the lines upon which further work can be done in particular sections. Part first considers the opportunities in Europe. 3000 w. St Ry Jour—Feb., 1899. Serial. 1st part. No. 25727 D.

Japan.

Foreign Capital in Japan. Discusses the prospects of land tenure under the new treaties, taking a rather hopeful view of the question. 2400 w. Engr, Lond—Feb. 3, 1899. No. 25917 A.

GOVERNMENTAL CONTROL.

Patents.

On the Validity of Mineral Wool Patents. A. D. Elbers. Gives extracts relating to compositions contained in early patents and reviews enumerated patents for the purpose of judging of their validity. 1800 w. Am Mfr & Ir Wld—Feb. 17, 1899. No. 26139.

LABOR.

British Workmen.

The Future of the British Workman. Presidential address delivered by Mr. John Inglis before the Institute of Marine Engineers, with editorial comment. 5000 w. Engng—Jan. 27, 1899. No. 25796 A.

Labor Question.

Some Recent Phases of the Labor Question. Part first considers coal miners and their unions, in the light of statistics furnished by the Labor Department of the British Board of Trade. 2300 w. Ir & Coal Trds Rev—Jan. 20, 1899. Serial. 1st part. No. 25636 A.

Railway Labor.

Condition of Railway Labor in Europe. Walter E. Weyl. A study of the general conditions of railway labor in a number of characteristic countries of Europe, undertaken to furnish material by which to judge American experience. 40000 w. Bul of U S Dept of Labor—Jan. 1899. No. 26124 D.

Strike.

The Weavers' Strike of Crefeld. An account of a strike among the weavers of this city of Prussia, with a copy of the agreement that is to govern them during the three months' truce agreed upon. 1000 w. U S Cons Repts, No. 344—Feb. 7, 1899. No. 25770 D.

Trade Disputes.

Arbitration and Conciliation in Trade Disputes. Discusses compulsory and voluntary arbitration, and the effect of public sentiment. 2300 w. Builder—Jan. 21, 1899. No. 25655 A.

Trade Unions.

The Yellow Book on Trade Unions in 1897. Comment on the recently issued English report of the Labor Department of the Board of Trade. 2000 w. Engr, Lond—Jan. 27, 1899. No. 25812 A.

Tropics.

The Labor Problem in the Tropics. W. Alleyne Ireland. On the necessity of securing a reliable labor supply to cultivate tropical products, as the natives will not work, giving a description of the successful contract system existing in the colony of British Guiana. 4000 w. Ap Pop Sci M—Feb., 1899. No. 25667 D.

MISCELLANY.

Cuba.

Cuba's Industrial Problems. Reviews the present conditions in the island and considers the serious problems to be solved in developing the

industries and fitting the people for self-government. 4000 w. Gunton's Mag—Feb., 1899. No. 25774 C.

Exhibition.

South African Exhibition. An account of the industrial and art exhibition in Grahamstown, and the products represented. 1000 w. U S Cons Repts, No. 352—Feb. 16, 1899. No. 25925 D.

Flash-Point.

The Flash-Point of Burning Oil. Editorial discussion of the effort in England to raise the flash-point to 100 deg. Fahr., and the effect it will have. 2500 w. Ind & Ir—Jan. 27, 1899. No. 25816 A.

Fuel Cost.

The Fuel Factor in the Cost of Production. Statistics showing the reduction in the fuel cost due to mechanical contrivances for getting and handling the coal, and preparing it for the use intended. 1500 w. Col Guard—Feb. 3, 1899. No. 25913 A.

Germany.

British View of Germany's Industrial Development. From the report of Mr. Gastrell, commercial attache to the British embassy in Berlin. Thinks success is due to mercantile enterprise and thoroughness of the people. 1200 w. U S Cons Repts, No. 357—Feb. 23, 1899. No. 26144 D.

Lumber.

American Lumber. B. E. Fernow. The value of this industry in the United States, with very interesting statistics, and the need of restorative measures. 3000 w. Chau—Feb., 1899. No. 25601 C.

Paris Exposition.

American Representation at the Paris Exposition of 1900. Ferdinand W. Peck. Address delivered before the Nat. Assn. of Mfrs. at Cincinnati. On the commercial benefit and patriotic duty involved. 2000 w. Elec Eng, N. Y—Feb. 9, 1899. No. 25839.

The Paris Exhibition of 1900. A statement of some of the delays and difficulties attending the preparation. 3700 w. Engng—Feb. 3, 1899. No. 25909 A.

Russia.

Russ.a as a World Power. Charles A. Conant. Considers the economic development of Russia is destined to soon make her the great competitor of the Anglo-Saxon race for the commercial and military supremacy of the world. 4300 w. N Am Rev—Feb., 1899. 25669 D.

Stone.

The Testing of Natural Stones in the Years 1895-96 and 1897-98. (Prüfung Natürlicher Gesteine in den Betriebsjahren 1895-96 bis 1897-98.) M. Gary. A very full report of the important work done by the Berlin Testing Laboratory during the past three years in investigating the properties of many kinds of building stone. An important paper. 15000 w. Mitt aus den Kgl Tech Versuchsanstalt—No. 5, 1898. No. 26043 G.

Technical Education.

Technical Education in Germany. An account of a conference to discuss German trade and manufacturing interests, with the resolutions passed. 700 w. U S Cons Repts, No. 329—Jan. 20, 1899. No. 25772 D.

Wheat Supply.

The Coming Exhaustion of the World's Wheat-Supply. Extract from the presidential address of Sir William Crookes at the last meeting of the British Assn. for the Adv. of Science. Statistics are given showing the outlook under present conditions, and suggestions given of what science can do to remedy these conditions. 2500 w. Eng News—Feb. 9, 1899. No. 25858.

ELECTRICAL ENGINEERING

COMMUNICATION.

Cable.

An All-British Cable System. Archibald S. Hurd. Considers the importance of connecting England directly with her colonies, outlines the scheme, and estimates the cost. 3800 w. Nineteenth Cent—Feb., 1899. No. 26196 D.

Coherers.

Experiments on Coherers. Alfred G. Dell. Describes laboratory experiments made to determine something concerning the action of coherers, giving results. 1200 w. Elec Eng., N. Y. —Feb. 16, 1899. No. 25923.

Duplex.

The Recording Duplex Instrument. (Das Recorder-Gegensprechen.) A. Luers. A description of the application of the Kelvin siphon recorder as a receiver in duplex telegraphy. 3500 w. Elektrotech Zeitschr—Feb. 2, 1899. No. 26077 B.

Exchange.

The New Exchange of the Central New York Telephone and Telegraph Co., at Syracuse, N. Y. Max Loewenthal. An illustrated detailed description of the plant, with historical review of the company. 4000 w. Elec. Eng, N. Y—Feb. 2, 1899. No. 25685.

Review.

The Year's Progress in Telephony and Telegraphy. Edward E. Clement. Review of the year 1898, noting the improvements, the part taking in the Spanish-American war, etc. Ill. 14500 w. Elec Engng—Feb., 1899. No. 26179 C.

Symbols.

The Telegraphic Transmission of Symbols. (Verfahren zur Telegraphischen Uebertragung von Zeichnungen.) Dr. J. Walter. A system of symbolical telegraphing by the use of a diagram of squares containing letters or syllables, the squares being indicated by numbers and letters. 3000 w. Electrotech Zeitschr—Jan. 18, 1899. No. 26070 B.

Telephony.

The Past Year's Advance in the Art of Telephony. Kempster B. Miller. A review of improvements during 1898, which consist mainly in the line of the perfection of details. Ill. 2800 w. Elec Wld—Feb. 18, 1899. No. 26142.

DISTRIBUTION.

Distributing.

Systems of Distributing and Generating Electricity. F. J. Warden-Stevens. Part first considers the two- and three-wire systems, and high and low pressure. 2000 w. Arch, Lond—Jan. 20, 1899. Serial. 1st part. No. 25640 A.

Transformers.

A New Transformer Diagram. Frank G. Baum. Describes a new method for obtaining the instantaneous values of the primary and secondary currents and magnetic flux of a transformer. 2500 w. Phys Rev—Feb., 1899. No. 26181 D.

ELECTRO-CHEMISTRY.

Accumulators.

Latest Progress in the Application of Storage Batteries. Joseph Appleton. Abstract of a paper read before the N. Y. Elec. Soc. Describes the conditions and methods of operation of the most interesting installations, and gives results from actual pracitce showing the present standing of storage batteries. Ill. 5800 w. Elec Wld—Feb. 4, 1899. No. 25686.

Notes on the Employment of Accumulators for

Electrically Propelled Vehicles. Percy Northey. Read before the Automobile Club of Great Britain and Ireland. A discussion of points of interest in securing satisfactory working of accumulators, and their employment for propelling vehicles. Also discussion. 6200 w. Automotor Jour—Jan., 1899. No. 25644 A.

See Street and Electric Tramways.

Alloys.

Some Investigations in Connection with the Electro-Deposition of Alloys. Sherard Cowper-Coles. Part first is a historical review of inventions in this field, and experiments made. 2400 w. Ind & Ir—Jan. 27, 1899. Serial. 1st part. No. 25815 A.

Caustic Soda.

Gravity-Electrolytic Processes for the Production of Caustic Soda. G. H. Robertson. Reviews the processes that have been devised and presents the claims of the latest introduced by the Oesterreichischer Verein für Chemische und Metallurische Produktion, in Bohemia. 1500 w. Elect'n, Lond—Jan. 27, 1899. No. 25820 A.

Electrolytic Processes.

Electrolytic Processes for the Extraction, Separation and Refining of Metals. Dr. D. Tommasi. Stating the advantages of the Tommasi electrolyzer, and discussing in part first the process for treating argentiferous lead. Ill. 3700 w. Elec Wld—Feb. 25, 1899. Serial. 1st part. No. 26172.

Electroplating.

Electroplating the Hulls of Vessels. Extracts from the report of A. A. Kundson concerning the condition of the hull of the tug "Assistance," which was electroplated with copper in 1895. Gives the method used and gives reasons for considering the method an improvement in copper sheathing. Ill. 1700 w. Elec Eng, N. Y.—Feb. 2, 1899. No. 25682.

Le Sueur Process.

The Le Sueur Process for the Electrolytic Production of Alkali and Chlorine. An account of the latest developments of this process which is now working with fair success. Also editorial. 2200 w. Elect'n, Lond—Feb. 10, 1899. No. 26109 A.

Voltaic Cell.

The Primary Voltaic Cell as a Transformer of Energy. Henry H. Norris. Read before the Cornell Elec. Soc. Considers the elements of the cells, faults of primary cells, commercial efficiency and their operation as electric and current generators, etc. 3000 w. Sib. Jour. of Engng—Feb., 1899. No. 26178 C.

ELECTRO-PHYSICS.

Conductivity.

Influence of the Surrounding Dielectric on the Conductivity of Copper Wire. Joseph Francis Merrill. A report of investigations and their results, with a brief review of the conclusions reached by Prof. Sanford and Prof. Carhart. 5000 w. Phys Rev—Feb., 1899. No. 26182 D.

The Electrolytic Conductivity of Pure Substances (Ueber das Elektrolytische Leitvermogen Reiner Substanzen). R. Abegg. An investigation of electrolytic conductivity, based upon the modern theory of Arrhenius. 1500 w. Zeitschr f Electrochemie—Feb. 2, 1899. No. 26080 G.

Discharge.

The Action of Magnetized Electrodes upon Electrical Discharge Phenomena in Rarefied Gases. C. E. S. Phillips. Describes experiments in this field and the apparatus used. 1500 w. Elect'n, Lond—Feb. 3, 1899. No. 25900 A.

Electric Spark.

The Constitution of the Electric Spark. Arthur Schuster and G. Hemsalech. Read before the Royal Society. Investigation undertaken primarily to measure the velocity of diffusion, with the special view of comparing different metals, and different lines of the same metal. 2500 w. Nature—Feb. 9, 1899. No. 25995 A.

Generation.

Electricity Direct from Coal. A. J. Rogers. Read at the meeting of the Northwestern Elec. Assn. A review of what has been done in this field, and the importance of having the problem solved. 1800 w. Elec, N. Y., Feb. 1, 1899. No. 25690.

Interrupter.

An Electrolytic Current Interrupter. (Ein Elektrolytischer Stromunterbrecher.) Dr. A. Wehnelt. An ingenious form of interrupter for us with induction coils; consisting of a lead plate and platinum wire as electrodes in dilute sulphuric acid. By the intermittent action the current is interrupted and restored in a very effective manner. 2000 w. Elektrotech Zeitschr—Jan. 26, 1899. No. 26073 B.

Electrical Interrupters for High-Tension Transmission for Continuous Currents. (Interrupteurs Electriques des Transformateurs à Haute Tension pour Courants Continus.) O. Rochefort. Describing several forms of mercurial interrupters for use in connection with the transforming of continuous current. 2000 w. Soc Ing Civ de France—Dec., 1898. No. 26026 F.

The Wehnelt Electrolytic Current Interrupter for Induction Coils. Dr. A. Wehnelt, in Elektrotechnische Zeitschrift. Describes experiments, giving results. Ill. 1200 w. Elec Eng, N. Y.—Feb. 16, 1899. No. 25924.

Magnetic Fields.

On Oscillatory and Rotary Magnetic Fields, and the Theory of the Single-Phase Motor. Michael B. Field. An investigation of the analysis and synthesis of various forms of magnetic fields, with the view of arriving at a satisfactory standpoint from which to attack the theory of the single-phase motor and to develop an approximate method for calculating the same. 2400 w. Elec Rev, Lond—Feb. 10, 1899. Serial. 1st part. No. 25990 A.

Magnetism.

"Residual" and "Permanent" Magnetism. J. Warren. An explanation of the writer's use of these terms, with a table giving residual magnetism results, obtained in some experiments. 700 w. Elec, Lond—Jan. 13, 1899. No. 25610 A.

Vibration Theory.

Agreement of the Thermodynamic or Vibration Theory with the Theory of Maxwell. (Uebereinstimmung des Thermodynamischen oder Vibrationstheorie mit der Theorie von Maxwell.) Rudolph Mewes. A mathematical discussion of the agreement of the wave theory with that elaborated in Maxwell's "Electricity and Magnetism." 2000 w. Elektrizität—Feb. 4, 1899. No. 26082 B.

GENERATING STATIONS.

Brazil.

The Electrical Plant at Para, Brazil. (Das Elektricitätswerk Pará, Brasilien.) Christen G. Host. An interesting account of the electric power plant and trolley lines recently constructed in the city of Para. 4000 w. Elektrotech Zeitschr—Feb. 2, 1899. No. 26075 B.

Currents.

Wagner Method for Deriving Polyphase from Single-Phase Currents. Describes a method devised by Herbert A. Wagner for deriving two or more alternating currents differing from one another in phase from a source of electricity supplying alternating currents of single phase. 700 w. Elec Eng, N. Y.—Feb. 2, 1899. No. 25683.

Design.

Trend of Central Station Design. B. J. Arnold. Read at meeting of the Northwestern Elec. Assn., at Milwaukee. Notes the points in accepted practice, discussing each briefly 3400 w. Elec, N. Y.—Feb. 8, 1899. Serial. 1st part. No. 25841.

Dynamos.

Points to Consider in a Dynamo. Arthur L. Rice. Briefly considers such points as can be determined without the test of continuous use. Diagrams. 1500 w. Engr, U. S. A.—Feb. 1, 1899. No. 25792.

Glasgow.

Glasgow Corporation New Electric Supply Work. A short history of this enterprise, with illustrated description of the new works. 3500 w. Elect'n, Lond—Feb. 3, 1899. No. 25899 A.

Installation.

Electricity at the Polhemus Memorial Clinic. Illustrates and describes a plant of exceptional thoroughness, and unique applications. 4300 w. Am Elect'n—Feb., 1899. No. 25828.

New York.

The Mammoth Generating Plant of the Third Avenue Railroad Co., New York City. Brief account of this power house, which will be the largest ever projected. Ill. 600 w. Elec Eng, N. Y.—Jan. 5, 1899. No. 25657.

Niagara.

The Birkinbine Plan for Utilizing Niagara Gorge Power. Brief illustrated description of the plan proposed. 600 w. Elec Eng, N. Y.—Feb. 9, 1899. No. 25838.

Paderno.

European Transmission Practice and the Water Power and Electric Plant at the Adda Rapids, near Paderno, Italy. Illustrates and describes an interesting hydraulic plant, where 13000 h. p. is transmitted a distance of 20 miles. 3800 w. Elec Eng, N. Y.—Feb. 9, 1899. Serial. 1st part. No. 25837.

Pittsburg, Pa.

Design and Construction of the 20th Street Power Station of the Consolidated Traction Company, Pittsburg, Pa. G. F. Greenwood. A statement of the existing conditions which made necessary the construction of this new station, with description of the plant. 5800 w. Pro of Engs' Club of W. Penna—Dec., 1898. No. 25-859 D.

Sparking.

The Short-Circuiting of the Bobbins and the Commutation of the Current of a Continuous Current Armature. (Ueber den Kurzschluss der Spulen and die Kommutation des Stromes eines Gleichstromankers.) E. Arnold and G. Mie. A highly mathematical discussion deriving equations for various conditions, with especial relations to the reduction of sparking. Serial, Part I. 4000 w. Elektrotech Zeitschr—Feb. 2, 1899. No. 26076 B.

St. Anthony's Falls.

Power House and Shops of Twin City Rapid Transit Company. Illustrated description of the water power plant at St. Anthony's Falls, method of distributing current, stations, shops, cars, etc. 5400 w. St. Ry Rev—Feb. 15, 1899. No. 25958 C.

HEATING AND WELDING.

Alternating.

Heating Appliances for Alternating Currents. (Appareils Thermiques pour Courants Alternatifs.) R. B. Ritter. Illustrating and describing tic devices of the Alioth Company, of Bâle, Switzerland, including kitchen and laundry apparatus. 1500 w. L'Electricien—Jan. 21, 1899. No. 26036 B.

Cooking.

The Parvillée System of Electric Heating. (Appareils de Chauffage par l'Electricité Systeme Parvillée.) J. A. Montpellier. A description of electric cooking devices of the Parvillée design, in which the heating effect is produced by the introduction of a metallo-céramique resistance. 1200 w. L'Electricien—Feb. 11, 1899. No. 26038 B.

LIGHTING.

Arc Lamps.

A Comparison of the New Volta Lamps, with the Old System. (Ueber die Beleuchtung durch die Neuen Volta Lampen im Vergleich zu dem Alten System.) Dr. W. Wedding. A discussion of photometric tests, by which the greatly superior efficiency of the new lamp is shown; there being either an increase in illumination or a reduction in cost. 4500 w. Elektrotech Zeitschr—Jan. 19, 1899. No. 26071 B.

A New Regulator for the Arc Lamp. (Nouveau Régulateur de Lampe à Arc.) Marcel Deprez. An illustrated description of the Combier & Duflos arc lamp, with an analysis of its action. 1500 w. Le Génie Civil—Jan. 21, 1899. No. 26004 D.

A 95 Volt Arc. Alton D. Adams. Describes a new arc lamp which has an induction coil in shunt with its regulating spools. 900 w. Elec. Eng., N. Y.—Feb. 23, 1899. No. 26166.

Arc Lamp Regulation. Alton D. Adams. Discusses the power consumed in regulating resistance, and how it may be utilized. 1000 w. Elec. Eng. N. Y.—Feb. 16, 1899. No. 25922.

The A B C Arc Lamps. An illustrated detailed description. 3000 w. Elec. Rev. Lond.—Feb. 10, 1899. No. 25992 A.

Candle Power.

On the use of the Methven Standard with Blackened Chimney. R. A. Fessenden. Calls attention to the error arising from this practice. 500 w. Elec Wld—Feb. 25, 1899. No. 26171.

The relation between Mean Spherical and Mean Horizontal Candle Power of Incandescent Lamps. R. A. Fessenden. Describes methods of making tests to determine if the distribution factor could be predicted from the length, position and shape of the filament, giving results. Ill. 800 w. Elec Wld—Feb. 25, 1899. No. 26170.

Carbons.

Biography of an Arc Lamp Carbon. An account of the material used and how the carbons are made. Illustrating the processes used in the works of the Washington (Pa.) Carbon Co. 1600 w. Am Elect'n—Feb., 1899. No. 25833.

Filaments.

Maxim Method of Making Filaments for High Voltage Incandescent Lamps. Illustrates the apparatus used and describes the process. 1400 w. Elec Eng, N. Y.—Feb. 9, 1899. No. 25840.

Gibraltar.

The Electric Lighting of Gibraltar. Illustrates and describes a recently inaugurated system for public and private electric supply, chiefly for lighting purposes. 1800 w. Elect'n, Lond—Jan. 20, 1899. No. 25641 A.

Head-Light.

See Railway Affairs, Motive Power.

Inductive Loads.

Inductive Loads (Arc Lamps and Motors) on Alternating-Current Transformers. D. C. Jackson. Abstract of a paper read before the Northwestern Elec. Assn, at Milwaukee. Calls attention to the effect of arc lamps, or fan motors, when connected to transformers. 1500 w. Elec Wld—Feb. 4, 1899. No. 25687.

Nernst Lamp.

Nernst's Electric Lamp. James Swinburne. Gives a brief review of the position of electric lighting and describes the Nernst lamp. Also considers the future outlook. Discussion. 4500 w. Jour Soc of Arts—Feb. 10, 1899. No. 25999 A.

Wiring.

Electrical House-Wiring Regulations. Comment on three papers read before the Inst. of Elec. Engs. (London), urging the putting installation business on a sound basis. 3500 w. Elec Rev, Lond—Jan. 27, 1899. No. 25817 A.

Interior Electric Wiring. H. N. Gardner. A few rules applying to the wiring of a frame house of moderate cost. 2000 w. W Elect'n—Feb. 18, 1899. No. 26168.

MEASUREMENT.

Alternating Current.

New Measuring Instruments for Alternating Currents. (Neue Wechselstrommess-Instrumente.) Dr. G. Benischke. A discussion of the construction and operation of the measuring instruments made by the Allgemeine Elektricitäts-Gesellschaft, of Berlin. 10,000 w. Elektrotech Zeitschr—Jan. 26, 1899. No. 26074 B.

Hysteresis.

The Hysteresis Errors of Electricity Meters, Containing Soft Iron Armatures. Wilbur M. Stine. Discusses the variable potential rheostat, designed by the writer, and the method of using it in the study of this subject. 2000 w. Elec Wld—Feb. 18, 1899. No. 26141.

The Hysteresis of Iron and Steel at Ordinary Temperatures and at the Temperature of Solid Carbon Dioxide. A. H. Thiessen. Investigations of the hysteresis of iron, steel and nickel-steel, giving diagrams and tables. 1600 w. Phys Rev—Feb., 1899. No. 26180 D.

Hysteresis Meter.

The Blondel & Carpentier Hysteresis Meter. (Sur l'Hystérésimètre Construit par MM. Blondel et Carpentier.) Marcel Deprez. A communication to the French Academy in which M. Deprez shows the identity of the Blondel & Carpentier hysteresis meter with one devised by himself several years before. 1000 w. Compts Rendus—Jan. 9, 1899. No. 26010 D.

Instruments.

Commercial Instruments for Indicating and Recording Electrical Quantities, with a note on the New Aron Meter. G. S. Shoults. Condensed paper read before the Northern Society of Elec. Engs. The requirements of such instruments are considered and the accuracy attainable. Ill. 1500 w. Elec Eng, Lond—Feb. 10, 1899. No. 26110 A.

Meter.

General Meter Practice. Lyman C. Reed. On the testing of electric meters in the consumers' premises. 1800 w. Am Elect'n—Feb., 1899. No. 25830.

Resistance.

The Contact Resistance of Carbon and Copper Brushes. A short digest of an article by E. Arnold, in Elektrotechnische Zirschrift, discussing this subject. 700 W. Elec Eng, Lond—Jan. 27,1899. No. 25821 A.

POWER APPLICATIONS.

Agricultural.

The Applications of Electricity to Agriculture in Germany. (L'Electrotechnie Agricole en Allemagne.) Paul Renaud. A long review of the extent to which electricity has been used in agricultural work in Germany, and a discussion of its possible progress in France and her colonies Many devices are illustrated. 15000 w. Bull de la Societe d'Encour—Jan., 1899. No. 26020 G.

The Borsig Electric Plow. (Der Elektrische Pflug der Maschinenfabrik von A. Borsig in Berlin.) F. Brutschke. Illustrating a system of transmission from a central point to a number of fields to deliver current to cable-drawn plows operated by electric motors. 1800 w. Elektrizität—Jan. 21, 1899. No. 26081 B.

Cloth Pressing.

Cloth Pressing by Electricity. Report by Mr. Ch. Monchel, on a new process known as the "electro-calidor" process, which consists of pressing cloth by means of boards heated by electricity. 1000 w. U S Cons Repts, No. 357—Feb. 23, 1899. No. 26143 D.

Crane.

Electrically Operated 150-Ton Jib Crane at Newport News Shipyard. Walter A. Post. Abstract of a paper read at the meeting of the Soc. of Naval Archts. and Marine Engs. A statement as to size, capacity, range of operation, etc., with description of particular details. Ill. 3000 w. Elec Eng. N. Y.—Feb. 2, 1899. No. 25684.

Electric Locomotive.

See Railway Affairs, Motive Power.

Electric Towing.

Electric Towing upon Navigable Waterways. Reviews the various attempts that have been made to solve the problem of towing boats on canals, and illustrates and describes the system devised by M. Galliot. He uses an electric traction engine. 1800 w. Sci Am Sup—Feb 4, 1899. No. 25699.

Exposition.

Electricity at the Paris Exposition of 1900. Georges Dary. A brilliant description of the plans which have been made for the electric lighting, traction and display at the coming exposition. 3000 w. Engineering Magazine—March, 1899. No. 26099 B.

Machine Driving.

Electric Driving at the Machine Works of the General Electric Company of Berlin. (Die Elektrische Kraftverteilung in den Maschinen-bauwerkstätten der Allgemeiner Elektricitäts-Gesellschaft, Berlin.) O. Lasche. A description of this important manufacturing establishment showing the great advantages which have been derived from the introduction of independent electric driving, for machine tools. Serial. Part I. Zeitschr d Ver Deutscher Ing—Feb. 4, 1899. No. 26066 D.

Motor.

The Modern Single-Phase Alternating-Current Motor. T. M. Meston. On the high efficiency of these machines, and the uses to which they are applied. 1500 w. Elec Wld—Feb. 4, 1899. No. 25689.

Motor Diagrams.

Induction Motor Diagrams. C. C. Hawkins. A detailed description of the graphical method, with illustrations. 1600 w. Elect'n, Lond—Jan. 27, 1899. Serial, 1st part. No. 25819 A.

Motor Installation.

Motor Installation at the Chicago "Daily News" Office. Charles A. Dresser. Read before the Chicago Elec. Assn. Describes the equipment and operation, with some comments on the improvement, and on other devices used in the press room. 3000 w. Elec, N. Y.—Feb. 22, 1899. No. 26146.

Separators.

The Magnetic Separation of Minerals. (Triage Magnétique des Minerais.) F. Schiff. A general discussion of the various methods which have been devised for the separation of minerals by the use of intense magnetic fields. 2000 w. 1 plate. Le Génie Civil—Jan. 14, 1899. No. 26000 D.

TRANSMISSION.

Transmission Line.

A Transmission Line to Los Angeles. Illustrates and describes the installation and the service rendered. 2700 W. St Ry Rev—Feb. 15, 1899. No. 25960 C.

Traveling Platform.

The Electric Platform of the Exposition. (Plate-Forme Electrique de l'Exposition.) An illustrated description of the experimental traveling platform constructed to demonstrate the practicability of the device on a large scale. 1000 w. La Revue Technique—Jan. 25, 1899. No. 26018 D.

MARINE ENGINEERING

American Line.

American Line Ships. Story of their operation in connection with mail subsidies, as told by Clement A. Griscom. 1800 W. Marine Engng—Feb. 9, 1899. No. 25872 C.

Channel Steamers.

The Belgian Steamers of the Ostend-Dover Line. (Les Paquebots Belges de la Ligne Ostende-Douvres.) D. Bellet. A very fully illustratd account of these fine new Channel steamers; referring especially to the Princess Clementine, of 1540 tons displacement, and of more than 22 knots speed. 3500 w. La Revue Technique—Dec. 25, 1898. No. 26014 D.

Congress.

The Transactions of the VII Maritime Congress in Brussels, 1898. (Ueber die Verhandlungen des VII Schiffahrts-Congresses in Brussel, 1898.) A. Schromm. A general review of the subjects discussed, with numerous illustrations of harbor improvement works, etc. 5000 w. Zeitschr d Oesterr Ing u Arch Ver—Feb. 3, 1899. No. 26057 B.

Copper Plating.

Copper Plating Vessels. Explains the advantage of copper as a sheathing for vessels, and describes a new system of depositing the copper. Ill. 1400 w. Ir Age—Feb. 23, 1899. No. 26162.

Inland Navigation.

Inland Navigation in Europe and North America, with Special Reference to Inland Navigation in England. Leveson Francis Vernon-Harcourt. Presents the importance of solving this problem, and notes the recent interest; reviews the waterways of N. America, Germany, France and Belgium; states the conditions in England, giving conclusions. Discussion. 16500 w. Jour Soc of Arts—Jan. 30, 1899. No. 25645 A.

Merchant Marine.

Efforts to Improve the French Merchant Marine. Gives the report of the parliamentary committee appointed by the Minister of Commerce for the purpose of considering the best measures for the upbuilding of the French merchant marine. 1800 w. U S Cons Repts, No. 350—Feb. 14, 1899. No. 25878 D.

Our Merchant Marine. Sereno E. Payne. Discusses the necessity of building up the American merchant marine and the course best to adopt. 2800 w. N Am Rev—Feb., 1899. No. 25670 D.

Oceanic.

The "Oceanic," and How It Was Launched. Interesting particulars in regard to this vessel and the manner of launching, which proved so successful. Ill. 5400 w. Engr, Lond—Jan. 20, 1899. No. 25630 A.

The "Oceanic." Illustrates the vessel before and immediately after the launch, giving some particulars of interest. 1200 w. Engng—Jan. 20, 1899. No. 25612 A.

The White Star Liner "Oceanic." Illustrates and describes this large vessel, and compares it with the "Great Eastern," giving also some account of the launching. 1800 w. Sci Am—Feb. 11, 1899. No. 25861.

Ocean Routes.

Routes Adopted by the Transatlantic Steamship Lines. (Routes Adoptées par les Compagnies Transatlantiques.) A statement of the new routes going into effect January 15, 1899, with chart of the North Atlantic. 1200 w. Le Yacht—Jan. 28, 1899. No. 26034 D.

Ocean Steamers.

The Structural Features of Large Ocean Steamers. Editorial discussion of the modifications made necessary by growth in dimensions. 1700 w. Engr, Lond—Feb. 10, 1899. No. 25976 A.

Pontoon Barge.

Vessel to Carry Canal Boats. Describing a novel craft designed for the Lake Erie service of the Cleveland Steel Canal-Boat Co. 1000 w. Marin Rev—Feb. 2, 1899. No. 25767.

Propulsion.

Discussion of the Mechanical Theory of Steamship Propulsion. Robert Mansel. The paper is a continuation of an article published in this journal on Oct. 14, 1898. Gives formula and graphical illustrations. 2500 w. Engr, Lond—Feb. 10, 1899. No. 25973 A.

Sailing Ships.

Steel vs. Wood as a Material for Sailing Ships, with Data of American Ships in Service. William A. Fairburn. Gives brief descriptions of vessels of both types, and claims the great superiority of steel over wooden vessels. Ill. Marine Engng—Feb., 1899. No. 25763 C.

Shipbuilders.

Thames Pioneer Shipbuilders and Marine Engineers. Biographical notes of some of the originators of these establishments, with photographs. 6500 w. Engr, Lond—Jan. 27, 1899. No. 25811 A.

Shipbuilding.

American Rivalry in the Ship Building Industry. Considers the conditions and causes that contribute to success in this field. 2200 w. Ir & Coal Trade Rev—Jan. 20, 1899. No. 25635 A.

The Shipbuilding Boom. Editorial on statistics given in Lloyd's Returns, with explanation of why there is a seeming disparity between Lloyd's and the published statistics given in a previous issue of this paper. 1500 w. Engng—Jan. 20, 1899. No. 25616 A.

The World's Shipbuilding in 1898. A clipping from a British journal showing the shipbuilding for the year just closed, with interesting comments. 1300 w. U S Cons Repts, No. 350—Feb. 14, 1899. No. 25879 D.

Steamer.

An Ice Breaking Steamer for Russia. A description of the powerful quadruple screw steamer Ermack, especially designed for the purpose of breaking the ice and keeping open the Northern ports of Russia. Engng—Feb. 24, 1899. No. 26370 A.

Submarine Boats.

Submarine Boats. Editorial discussion of the invention of Gustave Zede, stating its special features, and her performance as compared with other submarine boats. 1800 w. Engr, Lond—Jan. 20, 1899. No. 25633 A.

Transatlantic.

Transatlantic Passengers. Interesting statistics of the passenger traffic entering and leaving New York during the past year. 1000 w. Engng—Feb. 3, 1899. No. 25910 A.

Tug-Boat.

The Gypsum King. Illustrated description of the new steel sea-going tug-boat being built by the Burlee Dry Dock Company for the New York and Nova Scotia trade. 2300 w. Naut Gaz—Feb. 16, 1899. No. 26136.

Vibrations.

Vibrations of Steamships and Methods of Balancing Marine Engines. C. H. Peabody. Considers the cause of vibration to be due to the coincidence of the time of revolution of the engine to the natural time of vibration of the hull. 3500 w. Marine Engng—Feb., 1899. Serial. 1st part. No. 25762 C.

Yacht.

Twin-Screw Steam Yacht "Atmah." An illustrated description of the largest and most notable yacht built in Great Britain in 1898. 1300 w. Sci Am Sup—Feb. 18, 1899. No. 25942.

MECHANICAL ENGINEERING

AUTOMOBILISM.

Autocar.

The Autocar Industry. Illustrates a pleasing and novel construction, the invention of W. J. Still, and describes its special features. Also gives late news in reference to the use of compressed air in New York. 2500 w. Can Engr—Feb., 1899. No. 25938.

Cycle Exhibition.

Automobiles at the Late Cycle Exhibition. Illustrations showing types of most of the vehicles, with brief descriptions. 1500 w. Sci Am—Feb. 18, 1899. No. 25940.

Freight Wagons.

Automotor Freight Wagons and Freight Rates in England. Stating the desire for self-propelled freight road wagons in Great Britain, and the success thus far attained. Invites American competition. 2000 w. U. S. Cons Repts, No. 338—Jan. 31, 1898. No. 25638 D.

Haulage.

Motor v. Horse Haulage. An Account of Our Nine Months' Experience. S. H. Sparkes. Read before the Liverpool Self-Propelled Traffic Assn. Gives particulars of the service of a motor-van used by Messrs. Fox Brothers & Co., owners of large woolen mills in England. 3000 w. Ind & Ir—Jan. 20, 1899. Serial. 1st part. No. 25637 A.

Oil Motor Car.

The Koch Heavy Oil Motor Car. Illustrates this motor, which is considered the most successful of heavy oil motors which has appeared, and calls attention to some features. 1200 w. Engr, Lond—Feb. 3, 1899. No. 28921 A.

Tire Problem.

Automobiles and the Tire Problem. Opinions of prominent men in the trade concerning the effect of the automobile industry on the demand for rubber. 900 w. Ind Rub Wld—Feb. 1, 1899. No. 25754 D.

HYDRAULIC ENGINEERING.

Hydrodynamics.

The Selection of a Formula for Velocity (Choix d'une Formule de Célérité.) The report of a committee of the French Academy upon the flow of water, recommending the formula of M. Boussinesq. 1500 w. Comptes Rendus—Jan. 9, 1899. No. 26011 D.

Storage.

The Influence of Storage Reservoirs upon Water Power Plants. (Einfluss der Teiche auf den Betrieb der Wassertriebwerke.) Tiegel v. Lindenkron. An elaborate mathematical investigation of the water storage reservoir problem, using both analytical and graphical methods. 5000 w. Oesterr Monatschr f d Oeffent Bandienst—Feb., 1899. No. 26050 D.

Water-Power.

A Proposed Water-Power Improvement in the Gorge of the Niagara River. John Birkinbine. Outlines a plan for diverting a portion of the river into a canal which deliver 10000 cu. ft. per second at moderate velocity, capable of producing 35,000 h. p. Ill. 1800 w. Pro of Engs' Club of Phila.—Jan., 1899. No. 26127 D.

Water Powers in Southern California. C. G. Baldwin. Statements of the essential considerations which relate to these enterprises, discussing the causes of failure, the vital questions, and the cost of power. 4000 w. Jour of Elec—Jan., 1899. No. 26161.

Water Powers of Ontario. Thomas W. Gibson. From the report of the Ontario Bureau of Mines. An account of the vast number of waterfalls, the practical uses, with text of the act and regulations which were adopted in 1898. 2800 w. Can Elec News—Feb., 1898. No. 26137.

MACHINE WORKS AND FOUNDERIES.

Automatic Machinery.

The Designing of Automatic Machinery. Hanson Robinson. Read at meeting of the Baltimore Chapter of the Assn. of Am. Draftsmen. Discusses the questions that should be considered before beginning the designing of labor-saving machines. 1700 w. Am Mach—Feb. 16, 1899. No. 25927.

Ball Bearings.

See Street and Electric Tramways.

Boring Mill.

Unusual Profile Turning on a Boring Mill. Illustrated description of a boring mill containing some unusual features, and particulars of an unusual job done on it. 900 w. Am Mach—Feb. 9, 1899. No. 25835.

Chains.

Welded Chains. E. J. Taylor. Paper read before the Manchester Assn. of Engs. Describes the work and the testing. 2300 w. Mech Wld—Feb. 3, 1899. Serial. 1st part. No. 25896 A.

Crane.

A Petro-Automotor Crane. Illustrated description of an application of the petro-motor to work a movable crane. 1200 w. Automotor Jour—Jan., 1899. No. 25643 A.

Some Variations in Standard Crane Practice. Joseph Horner. Discusses differences in detail and workmanship, and the taste in design. 4800 w. Engng—Feb. 3, 1899. No. 25906 A.

Design.

Some Pump Problems. W. H. Booth. Reports some of the writer's investigations in connection with the design of artesian pumps. 2000 w. Am Mach—Feb. 2, 1899. No. 25700.

Dies.

Die Construction. George B. Painter. Illustrated description of a combination shearing, piercing, bending and forming die, applicable to a large variety of press work. 800 w. Am Mach—Feb. 23, 1899. No. 26159.

Fits.

Shrink and Force Bits. Jno. J. Wilmore. Reports experiments made by students in mechanical engineering, giving results and conclusions. Ill. 1400 w. Am Mach—Feb. 16, 1899. No. 25929. 25929.

Heavy Castings.

Casting a Harris-Corliss Engine Bed. R. H. Palmer. Illustrates and describes a cast for a 32-inch engine, weighing about 23,000 pounds. 1700 w. Am Mach—Feb. 16, 1899. No. 25928.

Instruments.

Measuring and Testing Instruments Used in the Manufacture of Naval Ordnance. E. J. Prindle. Illustrates and describes the instruments, the use of which makes possible the high degree of precision required. 3500 w. Sci Am—Feb. 25, 1899. No. 26154.

Jacks.

Hydraulic Jacks for Lifting Iron Bridges. (Hydraulische Vorrichtungen zum Heben von Eisernen Eisenbahnbrucken.) With illustrations of the powerful hydraulic jacks used in lifting the iron bridge near Dordrecht in Holland. 1800 w. Glasers Annalen—Feb. 1, 1899. No. 26047 D.

Machine Tool.

Boring, Threading and Countersinking Machine. From *Revue Industrielle.* Illustrated detailed description. 1500 w. Sci Am Sup—Feb. 11, 1899. No. 25864.

Molding.

Molding Cast Iron Columns. John S. Knoeppel. Gives points helpful to young molders. Ill. 1100 w. Foundry—Feb., 1899. No. 26130.

Rifling.

Rifling a Big Navy Gun. Edwin J. Prindle. Illustrates and describes the manner in which it is performed at the Naval Gun Factory at Washington, D. C. 900 w. Am Mach—Feb. 16, 1899. No. 25930.

Roller Bearing.

The Hyatt Roller Bearing. Report of the Committee on Science and the Arts, on the invention of J. W. Hyatt. Illustrates and describes the invention and reports experiments made, giving tabulated comparisons. 1200 w. Jour Fr Inst—Feb., 1899. No. 25776 D.

Shop Costs.

Machine Tool Depreciation as an Element of Manufacturing Cost. H. M. Norris. Discussing the practice of various establishments, and suggesting a solution of the problem from the author's experience, with forms and tables. 4500 w. Engineering Magazine—March, 1899. No. 26096 B.

Shop Practice.

Some Points of Practice from a Manchester Shop. F. J. M. The points illustrated and described were gathered from the establishment of Hans Renold, of Manchester, Eng. The principal business is the manufacture of transmission chains. 2500 w. Am Mach—Feb. 23, 1899. No. 26158.

Spraying.

Blackening Dry Sand Molds with Compressed Air. I. B. Thomas. Illustrates and describes the construction and operation of the apparatus used. 500 w. Foundry—Feb., 1899. No. 26129.

Tubing.

The Production of Tubes and Rods by Means of Hydraulic Presses. (Die Erzeugung von Rohren und Stangen Mittelst Hydraulischer Presse.) Otto Weiss. A paper before the German Society of Mechanical Engineers describing Dick's process of forming tubes of various sections from ductile metals. 4000 w. Giasers Annalen—Jan. 15, 1899. No. 26044 D.

Wood-Working Machinery.

The Development of Wood-Working Machinery. John Richards. Mr. Richards's second paper is devoted to the evolution of American log-sawing machines, from the small circular mill to the great band log-mills used on the enormous red-wood logs of the Pacific coast. 4500 w. Engineering Magazine—March, 1899. No. 26094 B.

Works Management.

Machine Shop Management in Europe and America. H. F. L. Orcutt. Mr. Orcutt's third paper deals mainly with the effects of environment on the efficiency of workmen, comparing the conditions under which mechanics live in Europe and America. 5000 w. Engineering Magazine—March, 1899. No. 26093 B.

On Works' Organization. Tom Westgarth. Paper read at a meeting of the Northeast Coast Inst. of Engs. and Shipbuilders. Suggestions intended for marine engineers, but applicable to any large works. 2000 w. Steamship—Feb., 1899. No. 25884 A.

MATERIALS OF CONSTRUCTION.

Resistance.

The Resistance of Tension Rods of Given Section to Shock. (Einiges über die Stossfestigkeit von Zugstangen Abgesetzten Querschnittes.) G. Stockhammer. Showing how the resistance to shock may, under certain conditions, be increased by a reduction of section. 200 w. Zeitschr d Oesterr Ing u Arch Ver—Jan. 27, 1899. No. 26056 B.

Specifications.

Standard Specifications for Steel. W. R. Webster. A discussion of the fairest specification requirements from the standpoint of the trained inspector, taking into account chemical composition, conditions of working, and effect of temperature. 4500 w. Engineering Magazine—March, 1899. No. 26095 B.

Testing.

Improved Devices for Testing Metals. (Appareils Nouveaux pour l'Essai des Métaux.) Ch. Fremont. Describing the application of recording devices to machines for testing the resistance to tension, punching and shearing, as well as drop tests. Photo-micrography is also discussed. 3000 w. Soc Ing Civ de France—Dec., 1898. No. 26027 F.

The Mechanical Testing of Metals. (Essais Mécaniques des Métaux.) Georges Charpy. The beginning of a treatise on testing of materials. The first portion consists of a description of the principal varieties of testing machines. Serial. Part I. 10000 w. Revue de Mécanique—Jan., 1899. No. 26024 H.

POWER AND TRANSMISSION.

Compressed Air.

Advantages of Compressed Air over Other Sources of Power in Deep Mining—Great Developments Predicted. R. P. Whitelaw. Read before the Mech. Engs' Assn. of S. Africa. Suggestions regarding the suction-valve chamber; how intercooling might be improved, etc. 4000 w. Compressed Air—Feb., 1899. No. 25676.

Driving Pumps by Compressed Air. William Cox. Explains how to determine in a simple manner the number of cubic feet of free air at a certain pressure necessary to pump a given quantity of water to a required height. Also means of ascertaining power cost, and other desirable information. 2000 w. Compressed Air—Feb., 1899. No. 25677.

Liquefied Gases.

Liquefied Gases and Air in the Industries. Ernesto Mancini. A review of experimental progress in this field, and the uses to which the gases have been or may be applied. 3800 w. Chau—Feb., 1899. No. 25602 C.

Lubrication.

Oil Used for Lubrication. Discusses various lubricants and calls attention to some practical methods of testing oils and oil mixtures. 3000 w. Mach, Lond—Jan. 15, 1899. No. 25646 A.

Machinery Driving.

See Electrical Engineering, Power Applications.

Ropes.

Rope Testing. George A. McCarthy and Ernest G. Matheson. Read before the Applied Science Graduates' Society of McGill Univ. Gives a brief account of the method of manufacturing ordinary ropes, and describes the testing of ropes as carried out in the laboratory. 1600 w. Can Engr—Feb., 1899. Serial. 1st part. No. 25937.

Tension.

Centrifugal Tension in Ropes and Belts. C. N. P. A reply to statements made by G. H. Kenyon, in a recent lecture on "Ropes and Rope Driving," with explanation of the writer's views. Ill. 1800 w. Mech Wld—Jan. 20, 1899. No. 25647 A.

SPECIAL MOTORS.

Air Motor.

The Hoadley Knight Compressed Air Motor. An illustrated description of the motor and its operation. 1000 w. Sci Am—Feb. 4, 1899. No. 25695.

Diesel.

Diesel's Rational Heat Motor. E. D. Meier. Reviews work in connection with steam, and conclusions that led to a renewal of interest in

the internal combustion engines, and the great advance made by Rudolf Diesel, describing his invention and its working. Ill. 6500 w. Sib Jour of Engng—Feb., 1899. No. 26177 C.

Notes on the Diesel Heat Motor. (Mitteilungen über den Dieselschen Wärmemotor.) R. Diesel. With a number of illustrations of recently constructed motors, and data of experiments with a variety of liquid fuels. 2 articles. 5000 w. Zeitschr d Ver Deutscher Ing—Jan. 14, Feb. 4, 1899. No. 26061 each D.

Gasoline Engines.

Tests of Gasoline Engines in Pumping Plants. Gives the results of a number of tests by J. W. Ledoux. 500 w. Eng Rec—Feb. 11, 1899. No. 25853.

Gas Power.

Gas Power. J. E. Dowson. Some interesting particulars relating to gas engines, and practical results of working them with generator gas. 2500 w. Gas Engs' Mag—Jan. 10, 1899. No. 25729 A.

The Riché Gas Process. (Le Gaz Riché.) A. Bainville. An account of the use of gas produced from the distillation of wood as a fuel for gas engines. The wood is distilled in closed retorts, furnishing a high grade of charcoal, and the gas gives more power in a gas engine than illuminating gas. 2000 w. L'Electricien—Jan. 28, 1899. No. 26037 B.

The Utilization of Blast-Furnace Gases. Editorial review of what has been already accomplished, considering the future outlook encouraging. 1500 w. Engr, Lond—Feb. 10, 1899. No. 25977 A.

STEAM ENGINEERING.

Air Pump.

Performance of a Vertical Air Pump without a Foot Valve. (Wirkungsweise einer Stehenden Kondensation-Luftpumpe ohne Saugventile.) H. Berg. A description and analysis of action of an improved form of air pump for use with condensing steam engines; the foot-valve is dispensed with, and a high efficiency maintained. 3500 w. Zeitschr d Ver Deutscher Ing—Jan. 28, 1899. No. 26064 D.

Boiler Coverings.

Tests of Locomotive Boiler Coverings. Abstracted from a paper by Robert Quayle, presented at the January meeting of the Western Ry. Club, giving a report of tests made on the branch line of the Chicago & Northwestern. 3300 w. R R Gaz—Feb. 17, 1899. No. 25947.

Boiler Explosion.

Barking Boiler Explosion. Reports important evidence given at the inquest. 4000 w. Engng—Jan. 20, 1899. No. 25617 A.

Boiler Explosion at Eccles. Gives briefly the construction and history of the boiler, with report of the investigation. 4000 w. Engng—Jan. 20, 1899. No. 25618 A.

Boilers.

Designing Boilers for a Small Street Railway Plant. William Kent. Part first considers the preliminary studies peculiar to the service required. 1600 w. St Ry Rev—Feb. 15, 1899. Serial. 1st part. No. 25963 C.

The Care of Steam Boilers. An abstract of the rules of the National Boiler and General Insurance Co., of Manchester, England. 3000 w. Eng Rec—Feb. 11, 1899. Serial. 1st part. No. 25851.

Calorimeters.

Combustion and Calorimeters. H. J. Williams. Extracts from a paper presented at the December meeting of the New England R. R. Club. Shows the importance of ascertaining the heating power of coals, and describes various calorimeters, stating their defects and advantages. 2800 w. R R Gaz—Feb. 17, 1899. No. 25952.

Coal Calorimetry.

Berthier Method of Coal Calorimetry. Charles V. Kerr. Describes this method of finding the heating power of fuels. Its practical convenience is claimed. 2500 w. Jour W Soc of Engs—Dec., 1898. No. 25673 D.

Calculating the Calorific Power of Coal from Analytical Data. D. De Paepe. *Bulletin Assn. Belge des Chemistes.* Explains the writer's method of determining the calorific power, and the conclusions reached. 700 w. Col. Guard—Jan. 27, 1899. No. 25799 A.

Coal Efficiency.

The Increased Efficiency of Coal. On the importance of getting as much motive power out of every pound of coal, indicating what has been done and what remains to be done. 1600 w. Col Guard—Jan. 20, 1899. No. 25623 A.

Compression.

The Compression of Steam in the Clearance Space. (La Compression de la Vapeur dans l'Espace Mort.) L. Anspach. A general review of the discussion between Professors Dwelshauvers-Dery and Boulvin, showing the correctness of the conclusions of the former, but urging the necessity of further experiments. 7500 w. Revue de Mécanique—Jan., 1899. No. 26023 H.

Condensing.

Central Condensers. (Centralcondensation.) Chr. Eberle. A discussion of the construction and use of a main condensing apparatus for the reception of the exhaust steam from a number of engines, with examples from existing plants. Serial. Part I. 3500 w. Stahl und Eisen—Feb. 1, 1899. No. 26041 D.

Condensers and Air Pumps. Illustrates and describes some of the salient features in the design and construction of a condensing plant. 2200 w. Prac Engr—Feb. 10, 1899. Serial. 1st part. No. 26107 A.

Water-Cooling, as Applied to Condensing. Horace W. Jarvis. Abstract of paper read at Middlesbrough meeting of the Cleveland Inst. of Engs. Remarks on how much condensing saves, with descriptions of various forms of coolers. Short discussion is given. 2000 w. Col Guard—Jan. 20, 1899. No. 25622 A.

Firing.

Plain Talks to the Boys. C. B. Conger. A talk on the subject of firing coal properly, confined principally to the practical and mechanical side. 2400 w. Loc Engng—Feb., 1899. No. 25791 C.

Flue Gases.

The Rapid Testing of Gases from Industrial Furnaces. (Sur l'Essai Rapide des Fumées dans des Foyers Industriel.) H. Le Chatelier. A description of a simple apparatus employing the principle of the changes in color of heated copper. 1000 w. Bull de la Societe d'Encour—Jan., 1899. No. 26021 G.

Fuel.

Burning Low-Priced Fuel. W. H. Wakeman. Points out objections to the use of culm or fine coal. 500 w. Am Mach—Feb. 9, 1899. No. 25834.

Liquid Fuel. A discussion of the advantages and disadvantages in connection with liquid fuel. A comparison of cost, with a description of Urquhart's pulverizer, as given in London Engineering, and related matter of interest concerning methods used in various countries. 4500 w. Locomotive—Dec., 1898. No. 25658.

Fuel Cost.

See Economics and Industry, Miscellany.

Governors.

The Controlling Power of Governors. (Die Verstellkraft von Regulatoren.) F. J. Weiss. A mathematical examination of the relations of the forces in centrifugal governors, with especial regard to the power available for the regulating mechanism. 3000 w. Zetischr d Ver Deutscher Ing—Jan. 21, 1899. No. 26062 D.

Hoisting Engines.

The Torque of Hoisting Engines. D. S. Kimball. Discusses the operations of hoisting en-

gines in mining, and the means of determining the torque. 1300 w. Sib Jour of Engng—Feb., 1899. No. 26176 C.

Indicator Springs.

Testing Indicator Springs. L. G. F. A description of several types of apparatus that have been used for testing indicator springs, both in this country and in Europe. Ill. 5000 w. Mach, N. Y.—Feb., 1899. No. 25722.

Mechanical Stokers.

Test of an American Stoker. Reviews a test made by G. H. Barrus on a plant in a cotton-mill at Lowell, Mass. 800 w. Eng Rec—Feb. 25, 1899. No. 26190.

Pyrometer.

Pneumatic Pyrometer and Gas Composimeter. Illustrated description of an instrument for indicating and recording furnace temperatures. Also a gas composimeter which indicates and records the composition of gases of combustion. 1500 w. Am Mach—Feb. 2, 1899. No. 25702.

Rotary Engine.

A Two-Piston Rotary Engine, with Variable Cut-Off. Illustrates and describes the construction and principle of operation of a novel engine. 1300 w. Am Mach—Feb. 2, 1899. No. 25701.

Smoke.

Apparatus for Consuming Smoke. From La Nature. A decree awarding prizes for the best smoke-consuming devices, in France, in the year 1894 brought numerous projects, and thirty were selected for study. Experiments were made, and the awards assigned. The article describes the apparatus of successful competitors. 2000 w. Sci Am Sup—Feb. 25, 1899. Serial. 1st part. No. 26157.

Steam Consumption.

Consumption of Steam by Warship Auxiliary Machinery. A Few Figures. F. W. Roller. Reports a careful investigation of the steam consumption of the auxiliary machinery in common use on the U. S. S. Nashville. 1300 w. Am Elect'n—Feb., 1899. No. 25829.

Economy of Steam Production. A. L. Harrison. Describes a flour mill plant in the central West, and the means of securing economy. 1300 w. Am Elect'n—Feb., 1899. No. 25832.

Theory.

A Defense of the Practical Theory of the Steam Engine. (Défense de la Théorie Pratique de la Machine a Vapeur.) V. Dwelshauvers-Dery. A general examination of the analysis of Hirn, as sustaining the author's experiments on the wastefulness of compression. 6000 w. Revue de Mecanique—Jan., 1899. No. 26022 H.

Water Gages.

Concerning Water Gages. W. H. Wakeman. Some suggestions relating to the use of the combination water column. 800 w. Am Mach—Feb. 23, 1899. No. 26160.

Water Softening.

Water-Softening Plants. On the advantages and process of water softening, the cost, the most approved method, and illustrations of the plant a the Wayne Knitting Mills of Fort Wayne, Ind. 2200 w. Eng & Min Jour—Feb. 4, 1899. No. 25787.

Water-Tube.

Some Advantages of Water-Tube Marine Boilers. George R. Bale. States the good features of these boilers and the advantages which have led to their almost exclusive adoption in warships, and their probable adoption by the merchant-marine. 3500 w. Prac Engr—Feb. 3, 1899. No. 25901 A.

MISCELLANY.

Aerodynamics.

The Aerodynamic Conditions of a Thin Plate. (Der Aerodynamische Schwebezustand einer Dünnen Platte.) Josef Popper. A critical discussion of the theory of v. Loessl concerning the conditions of soaring or floating of a thin plate in the air. Two papers. 8000 w. Zeitschr d Oesterr Ing u Arch Ver—Jan. 27, Feb. 3, 1899. No. 26055 each B.

Bending.

The Bending of Wood. (Le Cintrage des Bois.) A description of the apparatus for steaming and bending wood used in the works of the Eastern Railway of France at Romilly-sur-Seine. 4000 w. 2 plates. Rev Gen des Chem de Fer—Jan., 1899. No. 26031 F.

Engineering Practice.

The Application of the Science of Mechanics to Engineering Practice. Abstract of lecture by Prof. Barr, before a special meeting of the students of the Inst. of Civ. Eng., London. A general talk on the subject. 2000 w. Prac Engr—Feb. 10, 1899. No. 26108 A.

Handling.

Storage and Handling Devices for Material in Bulk. (Lager und Transportanlagen für Massengüter.) M. Buhle. A discussion of the various forms of conveyors, elevators, and similar devices for handling grain, coal and similar articles, especially in connection with harbor warehouses and storage buildings. Serial. Part I. Zeitschr d Ver Deutscher Ing—Jan. 28, 1899. No. 26063 D.

Refrigeration.

A Refrigerating Plant on the Pictet System. (Kälteerzeugungsanlage nach System Pictet.) W. Brautigam. An illustrated description of a large refrigerating plant on the Pictet system, with data and results of tests. 3500 w. Zeitschr d ver Deutscher Ing—Feb. 4, 1899. No. 26067 D.

The Refrigerating Plant of Val-de-Grâce. (Les Installations Frigorifiques du Val-de-Grâce.) An illustrated account of the refrigerating apparatus used for preservation of bodies awaiting identification, as used in several Paris hospitals, as well as at the morgue. 1200 w. Le Genie Civil—Jan. 21, 1899. No. 26002 D.

MILITARY ENGINEERING

Armor.

The Nickel Steel Armor Patents. Gives facts of a notable case recently decided by the President, with the basis for the decision. 2400 w. Ir Age—Feb. 9, 1899. No. 25867.

Artillery.

Rapid-Fire Mountain Gun of the Mexican Army. (Le Canon de Montagne a Tir Rapide de l'Armée Mexicaine.) F. Schiff. An illustrated description of the Mondragon system of light rapid-fire mountain artillery, as constructed by the St. Chamond works. Photographs and detailed drawings are given. 2000 w. 1 plate. Le Genie Civil—Jan. 28, 1899. No. 26005 D.

Battleships.

A Representative Battleship and Coast Defense Vessel of the French Navy. Illustrates and describes two important types of vessels designed by French naval architects. 1300 w. Sci Am Sup—Feb. 4, 1899. No. 25696.

Battleships and Monitors Now Building for the Navy. Illustrates and describes the eight

battleships and four monitors in process of construction. 1900 w. Sci Am—Feb. 25, 1899. No. 26156.

Repairing the Keel of a Battleship. Illustrated account of the repairs to the "Massachusetts," being carried on at the Brooklyn Navy Yard. 1000 w. Sci Am—Feb. 18., 1899. No. 25941.

Defences.

Our Coast Defences. On the coast defences of the United Kingdom, describing some recent work and criticising the patchwork character. Ill. 1500 w. Engr, Lond—Jan. 20, 1899. No. 25628 A.

Destroyer.

Fastest in the World. Illustrates and briefly describes the Chinese torpedo-boat destroyer Hai Lung, which holds the speed record of the world, attaining 36.7 knots. 700 w. Marine Rev—Feb. 2, 1899. No. 25766.

U. S. S. Stringham, Torpedo-Boat Destroyer under Construction at Wilmington, Del. Illustrates and describes this boat, now being constructed at Wilmington, Del., noting its novel features. 1000 w. Marine Engng—Feb., 1899. No. 25764 C.

Explosives.

Experiments with High Explosives in Large Guns. Hiram Stevens Maxim. An account of experimental investigations and their results. 4800 w. N Am Rev—Feb., 1899. No. 25668 D.

High Explosives in Guns and Shells. From Captain O'Neil's monograph upon the construction of guns and shells for the firing of high explosives, covering about all the experiments recently made in this country and abroad, and discussing especially the Gathmann system. 4500 w. Ir Age—Feb. 23, 1899. No. 26163.

France.

The Navy and New Construction at the Close of 1898. (La Marine et les Constructions Neuves a la Fin de 1898.) A review of the state of the French navy and the progress of the work now in course of construction. 2000 w. Le Yacht—Jan. 7, 1899. No. 26032 D.

Naval Engineers.

The Duties of Naval Engineers. The first of a series of articles giving a synopsis of their life on board ships of war. The present issue deals with the responsibility of the chief engineer, and the senior engineer. 2000 w. Engr, Lond—Feb. 10, 1899. Serial. 1st part. No. 25972 A.

Naval Experience.

Readings from Experiences in Naval Engineering. Commodore G. W. Melville. Commodore Melville's second paper deals mainly with the changed requirements due to increasing power, speed and economy, and gives important lessons learned during the late war. 4000 w. Engineering Magazine—March, 1899. No. 26090 B.

Naval Risk.

The Respective Risks of France and England. (Les Risques Respectifs de la France et del l'Angleterre.) V. Guillox. A study of the comparative weakness of the two countries in case of war. It is maintained that the vulnerability of England's merchant marine overbalances her preponderance in naval strength. 2000 w. Le Yacht—Jan. 14, 1899. No. 26033 D.

U. S. Navy.

Machinery in the United States Navy. Illustrations and specifications for the main engines of the new battleships Nos. 10, 11, and 12, as taken from Commodore Melville's report. Also editorial. 2500 w. Engr, Lond—Feb. 3, 1899. No. 25920 A.

Steam Engineering in the United States Navy. Editorial review of the annual report of Commodore George W. Melville. 1800 w. Engr, Lond—Jan. 27, 1899. No. 25813 A.

MINING AND METALLURGY

COAL AND COKE.

Air Crossings.

Air Crossings or Bridges. Gives their history, describes undercasts and overcasts, and discusses which is to be preferred and when. 1500 w. Mines & Min—Feb., 1899. No. 25737 C.

Coal Calorimetry.

See Mechanical Engineering, Steam Engineering.

Coalfield.

The Douglas Coalfield, Lanarkshire. Robert Weir. Abstract of a paper presented at meeting of the Mining Inst. of Scotland. The location is given, the deposits described, and the working conditions discussed. 1500 w. Col Guard—Feb. 10, 1899. No. 25989 A.

Coal Formation.

Side-Light upon Coal Formation. W. S. Gresley. A discussion of characteristics of plants which form the coal beds, and the manner in which they were deposited. 4000 w. Am Geol—Feb., 1899. No. 25885 D.

Coal Jigs.

The Oberegger System of Double-Acting Coal Jigs, with Reciprocating and Oscillating Piston. Translated from *Oesterreichische Zeitschrift für Berg und Hüttenwesen*. Illustrated description, with some of their advantages. 2000 w. Mines & Min—Feb., 1899. No. 25739 C.

Coal Mine.

A California Coal Mine. R. H. Norton. Brief account of the mine at Tesla. 800 w. Eng & Min Jour—Feb. 4, 1899. No. 25788.

Coal Washing.

Coal Efficiency and Coal Washing. On the improvement effected in the constituents of the coal and its general character by washing. 1000 w. Col Guard—Feb. 10, 1899. No. 25988 A.

Coal Working.

Various Methods of Winning Coal in the Dortmund District. From a communication to *Glückauf* by Bergassessor Trainer. Observations on the various systems of working, and the terms used to distinguish them. Ill. 3300 w. Col Guard—Jan. 27, 1899. No. 25801 A.

Coal Valuation.

The Valuation of Coals. N. W. Lord. Presented before the Am. Assn. for the Adv. of Science. Discusses a number of unpublished tests and analytical results, which have been collected from various sources. 3500 w. Eng News—Feb. 16, 1899. No. 25966.

Coke.

The Requirements of a Good Coke. Information from an article by O. Simmersbach, published in the *Revue des Mines de Liege*. The constituents are considered in detail. 1800 w. Ir & Coal Trds Rev—Jan. 27, 1899. No. 25806 A.

Colliery.

Warora Colliery. An account of the working of this colliery during the year 1897-98. 700 w. Ind Engng—Jan. 14, 1899. No. 25994 D.

Fuel.

See Mechanical Engineering, Steam Engineering.

Gob Fires.

The Origin of Gob Fires. H. Stokes. Abstract of address delivered at Mansfield, England. Explains the new theory that the combustion is brought about by the physico-chemical actions and reactions of gases, liquids, and solids in old gobs. 900 w. Col Guard—Jan. 27, 1899. No. 25805 A.

Water and Coal Dust v. Water and Spontaneous Combustion (Gob Fire). James Ashworth. A discussion of the advisability of treating with water, mines subject to spontaneous combustion, showing that the treatment is the worst possible, and discussing the safest treatment. 2800 w. Col Guard—Feb. 10, 1899. No. 25987 A.

Jigging.

The Use of Jigging Machines in Wet Separation Processes. Walter J. May. The importance of sizing in all jigging operations, the amount of grinding necessary and other things needed to make jigging satisfactory. 1300 w. Col. Guard—Jan. 27, 1899. No. 25804 A.

Rating.

The Rating of Coal Mines. Edward Boyle. Read at meeting of the Surveyors' Inst., London. Discusses the methods used in England to arrive at a ratable value of a colliery. 4800 w. Col Guard—Jan. 27, 1899. No. 25803 A.

Roof Pressure.

Location of Roof Pressure in Longwall Working. The conditions which determine whether or not the system is practicable. 1800 w. Mines & Min—Feb., 1899. No. 25738 C.

Spain.

Coal Production in Spain. Statistics for the past year, giving an idea of the condition of the mining industry in 1898. 400 w. Col Guard—Feb. 10, 1899. No. 25985 A.

Venezuela.

Lease of Coal Mines in Venezuela. Translated copy of a contract between the Government of Venezuela and an Italian firm, providing for the working of the Guanta coal mines. 900 w. U. S. Cons Repts, No. 345—Feb. 8, 1899. No. 25768 D.

COPPER.

Idaho.

The Copper Deposits of the "Seven Devils," Idaho. Waldemar Lindgren. The location, mining operations, topography, geology, mineral deposits, etc., are considered. 1800 w. Min & Sci Pr—Feb. 4, 1899. No. 25869.

Washington.

A Washington Copper Deposit. R. H. Norton. Illustrated description of a large deposit in the State of Washington. 900 w. Eng & Min Jour—Feb. 11, 1899. No. 25854.

GOLD AND SILVER.

Arrastra.

How to Build and Operate an Arrastra. William H. Washburn. Gives drawings of a typical arrastra in Oregon, with description. Also particulars of other similar work. 3000 w. Min & Sci Pr—Jan. 28, 1899. No. 25715.

Assaying.

The Assay of By-Products. H. F. Lofts. Discusses the question of pot assays and scorification assays with the view of drawing out a discussion of the best general method. 1800 w. Jour of Chem & Met Soc of S. Africa—Dec., 1898. No. 25759 E.

British Columbia.

The Cassiar District, British Columbia. From report on Cassiar Central Railway Mining Land Grant, by Edward D. Self. Describes this region, the geology, the discovery of gold, etc. Maps. 2500 w. Eng & Min Jour—Feb. 18, 1899. No. 26135.

Concentration.

Concentration and Treatment of Low Grade Ores. Edmund B. Kirby. The problems involved and history of the process. Discussing the advantages and disadvantages of the German, the Missouri, the Lake Superior, and the Stamp mill systems. 6000 w. Mines & Min—Feb., 1899. No. 25736 C.

Cripple Creek.

The Mining Investor's Map of Cripple Creek Mining District, Fremont and El Paso Counties, Colorado. Compiled from records of the U. S. Surveyor General and other authentic sources of information issued by the Colorado Springs Gazette Publishing Co. Min Invest—Feb. 6, 1899. No. 25871.

Cyanide.

Cyaniding at Bingham, Utah. An account of the recovery of gold from an acid solution at the Old Jordan Mill, taken from notes of A. F. Holden, under whose direction this success was achieved. 1000 w. Eng & Min Jour—Jan. 28, 1899. No. 25603.

Cyaniding Base Ores. Matt. W. Alderson. The treatment of the base ores at Cripple Creek is described, and the subject generally discussed. 1400 w. Min & Sci Pr—Feb. 4, 1899. No. 25870.

Some Modifications of the Cyanide Process. Brief abstracts of descriptions of modifications proposed by European workers. The Pape-Henneberg and Gepner-Diehl combination process, and the Netto process. 1700 w. Min & Sci Pr—Jan. 28, 1899. No. 25714.

The Latest Cyanide Plant in the Transvaal. A description of the Henry Nourse Gold Mining Company's plant, in the Witwatersrand District, which shows the latest improvements in the treatment of tailings. 1600 w. Eng & Min Jour—Feb. 25, 1899. No. 26193.

Gold Fields,

Central Idaho Gold Field. Don Maguire. Describes a strange and comparatively unknown region, which promises rich returns. 3000 w. Mines & Min—Feb., 1899. No. 25734 C.

The Geology and Archaeology of the California Gold Fields. W. J. McGee and W. H. Holmes. Abstract of a paper read at meeting of the Geol. Soc. of America. Describes the geological changes that appear to have taken place, and the fossils and relics found. 1000 w. Sci Am Sup—Feb. 4, 1899. No. 25697.

High Mines.

Some High Mines of Telluride, Colorado. Illustrations, with brief account of the mines of Savage Basin and Silver Pick Basin. 500 w. Min & Sci Pr—Jan. 28, 1899. No. 25716.

Montana.

The Cedar Creek Placers, Montana. Fred D. Smith. The location and working of these placers. Ill. 1200 w. Eng & Min Jour—Feb. 4, 1899. No. 25786.

Nova Scotia.

The Dufferin. Particulars of this interesting mine, giving its history and many illustrations of its plant. 2800 w. Can Min Rev—Jan. 31, 1899. No. 25718 B.

Placer Mining.

Placer Mining in California. Arthur Lakes. The condition of the industry at present and an account of its former greatness. 2800 w. Mines & Min—Feb., 1899. No. 25735 C.

Precipitation.

A Zinc Process for Precipitating Gold from Weak Solutions. T. L. Carter. Continued discussion of this paper. 5000 w. Jour of Chem & Met Soc of S. Africa—Dec., 1898. No. 25761 E.

Rhodesia.

Rhodesia and Its Mines in 1898. William Fischer Wilkinson. An account of the prospects of the gold mines of South Africa, containing much interesting information. Ill. 8500 w. Jour Soc of Arts—Feb. 3, 1899. No. 25897 A.

Roasting Furnace.

The Herreshoff Roasting Furnace. Peter S. Gilchrist. Illustrated description and statement of advantages claimed. 1300 w. Mod Mach—Feb., 1899. No. 25889.

Slimes.

The "Electro-Zinc" Process, and experimental Researches Which Led to Its Development. W. Battel. Describes experimental work and the writer's method of precipitating gold and silver by the "electro-zinc" process. 1500 w. Min & Sci Pr—Feb. 18, 1899. Serial. 1st part. No. 26173.

Sulphide Ores.

The Oxidizing of Sulphide Ores. C. Woodman. General remarks on recent advances in gold mining and extraction, with an account of the Koneman process. 2400 w. Aust Min Stand—Dec. 29, 1898. Serial. 1st part. No. 25653 B.

IRON AND STEEL.

Blast Furnaces.

Blast Furnace Management. F. Louis Grammer. Concerning officers and their duties, and some practical points in regard to furnace work. 5700 w. Mines & Min—Feb., 1899. No. 25740 C.

The Evolution of the Blast-Furnace. A. H. Sexton. Abstract of a paper communicated to the Philosophical Society of Glasgow. Historical review of progress. 2000 w. Col Guard—Feb. 3, 1899. No. 25915 A.

Cupola Melting.

Blast in Cupola Meltings. Dr. Edward Kirk. From a new work on Cupola Practice, now in press. Considers the means which have been devised for supplying the required amount of air. 2300 w. Ir Trd Rev—Feb. 9, 1899. No. 25865.

Melting Iron in the Cupola. Edward Kirk. From a forthcoming work on Cupola Practice. Gives a case of bad melting and the cause and remedy. 2500 w. Ir Trd Rev—Feb. 16, 1899. No. 26138.

Iron Making.

The "Art" of Iron Making in 1750. A copy of old engravings and letter press, illustrating and describing the methods employed about the middle of the last century. 1800 w. Ir & St Trds Jour—Jan. 28, 1899. 1st part. No. 25883 A.

Iron Silicides.

The Commercial Manufacture of Iron Silicides. G. de Chalmot. Abstract of a paper in the Am Jour of Chemistry. Deals with silicides containing 25 to 50 per cent. of silicon. 1200 w. Eng & Min Jour—Feb. 18, 1899. No. 26134.

Malleable Iron.

Development of the Malleable Iron Industry in the United States. George C. Davis. Gives an historical account of this industry since 1835. 3400 w. Ir Trd Rev—Feb. 9, 1899. No. 25866.

Malleable Cast Iron. Erastus C. Wheeler. Deals with the effects of impurities found in pig iron. 4000 w. Ir Age—Feb. 16, 1899. Serial. 1st part. No. 25932.

Patents.

See Economics and Industry, Gov. Control.

Steels.

Special Nickel, Chromium, and Silicon Steels. A. Abraham. Abstract from the *Annales des Mines*. Relates the success attained in the use of nickel steel for armor plates, and the tests made, the use of nickel in the manufacture of gun steel, and considers high nickel steels and nickel-chromium steels. 4000 w. Ir Age—Feb. 2, 1899. No. 25691.

Sweden.

The Swedish-Norwegian Lulea-Ofoten Railway. (Die Schwedisch-Norweigische Unionsbahn Lulea-Ofoten.) Especially devoted to the development of the Swedish iron ore districts, with photogravrs and colored map. Serial. Part I. Stahl und Eisen—Jan. 15, 1899. No. 26040 D.

MINING.

Belgium.

The Operation of the Mines of Belgium. (De l'Exploitation des Mines en Belgique.) H. Kuborn. A review of the Belgian mines, with especial reference to the conditions of health and safety of the employees. Tables of data are given from 1850 to the present time. 4500 w. La Revue Technique—Jan. 25, 1899. No. 26019 D.

China.

Mining and Railway Companies in China. Comments on the seeming chaos prevailing, and discusses the new regulations which have been preferred by the Tsung-li-Yamen, for regulating railway and mining enterprises. 1700 w. Engng—Feb. 3, 1899. No. 25911 A.

Regulations for Mines and Railways in China. Translation of the regulations prepared by the bureau of control for mines and railways. 1400 w. U. S. Cons Repts, No. 355—Feb. 20, 1899. No. 25980 D.

East Africa.

Mining and Geological Conditions in German East-Africa. (Die Bergmannischen und Geologischen Verhältnisse in Deutsch Ost-Afrika.) A report by Assessor Bornhardt, showing that the mineral resources of the country, so far as can be determined at present, are insignificant. 2500 w. Glückauf—Jan. 28, 1899. No. 26085 B.

Metallurgy.

Notes on Experimental Metallurgy. J. E. Clennel. An account of experimental methods used in America. 4300 w. Jour of Chem & Met Soc of S. Africa—Dec., 1898. No. 25760 E.

Mine Development.

Some Needed Aids to Development of Mines. John W. Gray. Thinks the things most needed are cheap power, easy and economical transportation and low reduction charges, and the education and training of the worker. 1700 w. Min & Sci Pr—Jan. 28, 1899. No. 25713.

Mine Ventilation.

Root Principles of Mine Ventilation. Deals with the nature of theory and the atomic theory. 6300 w. Col Guard—Jan. 27, 1899. Serial. 1st part. No. 25798 A.

Root Principles of Mine Ventilation. A study of the general theory of force. 5300 w. Col Guard—Feb. 10, 1899. No. 25986 A.

Should Mine Ventilation Be Positive or Negative? Extract from a work by Mr. Haton de la Goupilliere. Discusses the advantages and disadvantages of pressure and exhaust fans. 1000 w. Col Guard—Jan. 20, 1899. No. 25620 A.

Mining Law.

The Statute of Limitations, with Regard to Mining Trespass. Cites cases illustrating English law on this subject. 1200 w. Col Guard—Jan. 27, 1899. No. 25800 A.

Philippines.

Prospective Mines in the Philippines. Extracts from the United States Mint Report for 1898. 2700 w. Min Rept—Jan. 26, 1899. No. 25654.

Pumping.

Kley Pumping Engine at the Franz Shaft at Idria. (Die Kleysche Wasserhaltungs-Dampfmaschinenanlage am Franzschachte in Idria.) Karl Habermann. A description and analysis of the operation of this compound beam pumping engine, together with data and results of tests. Serial. Part I. 3000 w. 2 plates. Oesterr Zeitschr f Berg-u Hüttenwesen—Jan. 21, 1899. No. 26083 B.

Kley Steam Pump at the Franz Shaft (Idria). Karl Habermann. *Oesterreichische Zeitschrift für Berg und Hüttenwesen.* Illustrated description. 1600 w. Col Guard—Jan. 27, 1899. Serial. 1st part. No. 25802 A.

Modern Underground Mine-Pumping Machinery. (Neuere Unterirdische Wasserhaltungsmaschinen fur Bergwerke.) B. Gerdau. A very fully illustrated account of some recent mine

pumps, driven by steam, hydraulic pressure, and electricity, and placed in the mine, instead of at the surface. 2 articles. 1 plate. 7000 w. Zeitschr d Ver Deutscher Ing—Jan. 14, 21, 1899. No. 26060 each D.

Safety Catch.

The Oberegger Safety Catch for Mine Cages. Translated from *Oesterreichische Zeitschrift für Berg und Hüttenwesen.* Illustrates and describes the catch and its operation. 800 w. Ir & Coal Trds Rev—Jan. 27, 1899. No. 25809 A.

Shafts.

New Arrangements for Closing Mine Shafts. From communication to *Glückauf* of Essen-an der-Ruhr, Westphalia. Illustrates and describes several automatic devices, which satisfy the conditions required. 2500 w. Col Guard—Jan. 20, 1899. No. 25621 A.

Shaft Sinking.

Sinking Deep Shafts with the Aid of Congelation. M. Saclier. From a communication to the Societe de l'Industrie Minerale. On the precautions necessary, especially in sinking to great depths. 1300 w. Col Guard—Feb. 3, 1899. No. 25912 A.

The Deepening of No. II. Shaft at the Victor Mine at Rauxel. (Das Abteufen des Schachtes II. der Zeche Victor bei Rauxel.) An account of a difficult piece of shaft sinking through sand and watery strata; the Kind-Chaudron method being employed, with a closed tubular section through the quicksand. The total depth is about 800 feet. 4000 w. 2 plates. Gluckauf—Jan. 14, 1899. No. 26084 B.

Surface Water.

Surface Water and Underground Workings. M. Leon Michel. From a paper published in the Bulletin de la Societe de l'Industrie Minerale. The injury to underground workings from surface water, and the mine owner's means of securing protection, from a French point of view. 2200 w. Col Guard—Jan. 20, 1899. No. 25624 A.

MISCELLANY.

Aluminum.

Aluminum as a Reducing Agent and Accumulator of Heat. (Ueber das Aluminum als Reductionsmittel und Wärme-Accumulator.) Dr. H. Seidel. A discussion of the experiments of Goldschmidt concerning the production of high temperatures by the use of aluminum. 2000 w. Zeitschr d Oesterr Ing u Arch Ver—Jan. 13, 1899. No. 26051 B.

Some Properties of Aluminum. (Sur quelques Propriétés de l'Aluminum.) A. Ditte. A communication to the French Academy devoted especially to a study of the materials by which aluminum is attacked. 2500 w. Comptes Rendus—Jan. 25, 1899. No. 26012 D.

Bitumens.

The Genesis of Petroleum and Asphaltum in California. A. S. Cooper. Part first discusses the origin of hydrocarbons. 1800 w. Min & Sci Pr—Feb. 4, 1899. Serial. 1st part. No. 25868.

Diamonds.

The South African Diamond District. Prepared by the Philadelphia Commercial Museum from South African correspondence. Where the diamonds occur and a description of the machinery and methods used in mining them. 2000 w. Mines & Min—Feb., 1899. No. 25741 C.

Glass.

New Uses of Glass. An account of glass used as a material for paving; also for the construction of houses. 900 w. U. S. Cons Repts, No. 354—Feb. 18, 1899. No. 25953 D.

Natural Gas.

Fluctuations in the Composition of Natural Gas; and a Method for the Determination of Nitrogen in Gas Mixtures. Francis C. Phillips. Describes experiments made in studying the causes of fluctuation in the heating power. 4500 w. Pro of Engs' Club of W Penna—Dec., 1898. No. 25860 D.

Platinum.

Platinum. David T. Day. From the U. S. Geological Survey. Information concerning the production, localities of occurrence, and refining establishments. 2200 w. Min & Sci Pr—Jan. 28, 1899. No. 25712.

Platinum in Yukon. Clipping from a local paper giving a report of a recent discovery, which may prove of great value. 1000 w. U. S. Cons Repts, No. 344—Feb. 7, 1899. No. 25769 D.

Separators.

See Electrical Engineering, Power Applications.

Statistics.

Statistics of the Mineral Industry of France and Algeria in 1897. (Statistique de l'Industrie Minérale en France et en Algerie pour l'annee 1897.) A general review from the official reports, including also brief statistics of the generation and use of steam. 2500 w. Le Génie Civil—Feb. 4, 1899. No. 26009 D.

Talc.

Fibrous Talc in St. Lawrence County, New York. J. Nelson Nevius. Illustrates and describes the deposits as far as explored, and the manner of mining and working. 3000 w. Eng & Min Jour—Feb. 25, 1899. No. 26192.

MUNICIPAL ENGINEERING

GAS SUPPLY.

Acetylene.

Acetylene Gas. Vivian B. Lewes. Reviews the history of its discovery, its properties, methods of production, etc. 5400 w. Ill. Car & Build—Feb. 10, 1899. No. 25981 A.

Risks in the Use of Calcium Carbide and Acetylene. E. V. French. Report prepared for the Boston Manufacturers' Mutual Fire Insurance Co. 1000 w. Eng News—Feb. 23, 1899. No. 26147.

The Explosibility of Acetylene at Low Temperatures. (Sur l'Explosibilité de l'Acétylene aux Basses Temperatures.) G. Claude. A note showing great solubility of acetylene in acetone when a low temperature is maintained, and also the freedom from explosion under such conditions. 600 w. Comptes Rendus—Jan. 30, 1899. No. 26013 D.

The Hygienic Aspect of Acetylene. Translated and condensed from a paper read before the Academy of Medicine, Paris. Some points concerning its excellence as an illuminant, the circumstances under which it is explosible, etc. 900 w. Plumb & Dec—Feb. 1, 1899. No. 26105 A.

Edinburgh.

New Gas-Works for Edinburgh. Extracts from the report of W. R. Herring, which gives an outline of the opinions of deputations sent to the English and Continental towns to collect information to guide in the laying out of the large gas-works to be built on the banks of the Forth at Granton. Plan. 6400 w. Gas Wld—Jan. 21, 1899. No. 25648 A.

Gas Piping.

Gas Piping in Buildings. John Lyman Faxon. Abstract of an article contributed to the Boston *Transcript*. The dangers of gas fixtures and methods of avoiding them. 1800 w. Eng Rec—Feb. 18, 1899. No. 26122.

Gas Works.

Gas Works at Edinburgh. A summary of Mr. Herring's report, as published in the Scotsman, Edinburgh, Jan. 16, 1899. 1500 w. U. S. Cons Repts, No. 356—Feb. 21, 1899. No. 26113 D.

Meter.

A Field for the Automatic Gas Meter. Edward A. Harman. A discussion of the automatic meter as a factor in extending the use of gas for lighting and cooking; and showing the simplification in accounting effected by its use. 1200 w. Engineering Magazine—March 1899. No. 26097 B.

Photometry.

Photometry in Germany. Digest of the instructions issued by the committee of the German Assn. of Gas and Water Engs. for testing the illuminating power of gas. 3400 w. Jour Gas Lgt—Jan. 24, 1899. No. 25719 A.

Regulations.

Revised Gas Fitting Regulations of Boston. A copy of the regulations adopted, with a series of illustrations showing how to do work properly. 1100 w. Met Work—Feb. 25, 1899. No. 26169.

Rosin Gas.

A Southern Rosin Gas Plant. F. H. Shelton. Notes of a plant which supplies light to the Western Home of the Insane, at Staunton, Va. 1100 w. Am Gas Lght Jour—Feb. 6, 1899. No. 25789.

Sulphate of Ammonia.

The Market for Sulphate of Ammonia Last Year. Extracts from the Annual Review, issued by Messrs. Bradley and Hirsch, of Liverpool. 3300 w. Jour Gas Lgt—Jan. 24, 1899. No. 25721 A.

Under Water.

A Gas Works Under Water. An account of the catastrophe at Littlehampton, Eng., which left the inhabitants seven days without a supply of gas. 2300 w. Jour Gas Lgt—Jan. 24, 1899. No. 25720 A.

SEWERAGE.

Sewage.

Precipitation and Filtration of Sewage. G. C. Mason. Brief account of the sewerage system at the Southern Indiana Hospital for Insane, Evansville, Ind. 900 w. Dom Engng—Feb., 1899. No. 26164 C.

Sewage, Its Purification and Disposal. Four papers bearing on this subject, by H. Kenwood and W. Butler, S. Rideal, W. D. Scott-Moncrieff, and W. E. Adeney, with discussion. 22300 w. Jour of San Inst—Jan., 1899. No. 25783 F.

Sewage Disposal.

Sewage Disposal at Woonsocket, R. I. Illustrated description of the covered settling basins and filtration system recently built. 1500 w. Eng Rec—Feb. 18, 1899. No. 26114.

Sewage Disposal for Country Houses. Explaining how their work of purification may be carried on by means of artificial filtration and land-irrigation. 1800 w. San Rec—Feb. 10, 1899. No. 26100 A.

Sewage Disposal in Connection with Tidal Waters. H. Bertram Nichols. Particulars relating to what has been done in some of the principal English seaside towns, the methods of treatment adopted, and the points of discharge. Discussion. 5000 w. Jour of San Inst—Jan., 1899. No. 25778 F.

The Necessity of Effective Means of Sewage Disposal. Elmer L. Andrews. Considers nature's manner of disposal of wastes, the danger of allowing water to become polluted by sewage, and the means of solving the problem. 2000 w. Munic Engng—Feb., 1899. No. 25679 C.

The Report of the Connecticut Sewage Disposal Commission. Abstract of a valuable report on the disposal of sewage under conditions existing in the State named. 2300 w. Eng News —Feb. 16, 1899. No. 25971.

Sewage Purification.

Experiments with Stale and Partially Septic Sewage on the Brockton Filter Beds. Outlines the difficulties met with in disposing of sludge, and describes experiments made at Brockton, Mass. Editorial comment. 3300 w. Eng News —Feb. 2, 1899. No. 25704.

The Champaign Septic Tank. Describes the construction of two tanks at Champaign, Ill., and gives a statement of their working. 1000 w. Eng Rec—Feb. 11, 1899. No. 25845.

The Purification of Sewage by Bacteria. Arthur J. Martin. Address delivered to the Belfast Natural Hist. & Phil. Soc. Part first is largely introductory, showing the nature and properties of sewage. Ill. 2000 w. San Rec —Feb. 10, 1899. Serial. 1st part. No. 26101 A.

Sewage Sludges.

Sewage Sludges. Reviews the work of Dr. W. E. Adeney in demonstrating that sludge can be prevented from having offensive "after-putrefaction." 2000 w. Eng Rec—Feb. 4, 1899. No. 25750.

STREETS AND PAVEMENTS.

Asphalt.

Recent Municipal Work in Washington. Describes mainly the asphalt-paving work. 2200 w. Eng Rec—Feb. 11, 1899. No. 25849.

Asphalt Mixing.

Petroleum Residuum as a Flux for Asphalt. Describes experiments made in Washington to determine whether petroleum residuum was a good softener for asphalt. 3000 w. Eng Rec—Feb. 18, 1899. No. 26117.

Brick.

Brick Pavements and Paving Brick. A. D. Thompson. On the merits of brick as a paving material, the methods of construction, the testing of paving brick and the price. 2300 w. Brick—Feb., 1899. No. 25709.

How to Make Further Improvement in the Manufacture of Paving Brick. F. Plumb. A discussion suggesting the field for experiment. 800 w. Brick—Feb., 1899. No. 25710.

The Future of Brick Pavements in Chicago. Frank W. Moulton. Reports the condition of the wood pavement, the menace to health, the advantages of good paving, etc., and urges the claims of brick as the best material to use. 3300 w. Brick—Feb., 1899. No. 25711.

London Streets.

London Street Improvements. G. Shaw Lefevre. Describes what has been done of late years and what it is possible to do in the future, with a criticism of the views of J. Wolfe Barry. 7000 w. Contemporary Rev—Feb., 1899. No. 26198 D.

Pavement.

The Pavement of the Cathedral of Siena. Illustrated description and historical account of this unique pavement. 900 w. Sci Am—Feb. 11, 1899. No. 25862.

Street Grades.

Street Grades and Cross-Sections in Asphalt and Cement. Robert P. Woods. Illustrates and describes the method adopted by the writer in arranging the grades and cross-sections in a part of the business district of Wabash, Ind. 1800 w. Pro of Am Soc of Civ Engs—Feb., 1899. No. 26191 F.

Street Sweepings.

Value of Street Sweepings. Edward A. O'dham. Reports results of investigations made to determine the fertilizing value of street sweepings. 1400 w. Munic Engng—Feb., 1899. No. 25680 C.

Vancouver, B. C.

Pavements in Vancouver, B. C. A. K. Stuart. Read before the Canadian Soc. of Civ. Engs., Feb. 8, 1899. A comparison of the two kinds of pavement used, bitminous rock and wood blocks, discussing their relative merits and adaptability to this humid climate. 3800 w. Adv. Proof. No. 25926 D.

WATER SUPPLY.

Catchment Area.

The Purchase of the Catchment Area as a Means of Protecting the Sources of a Public Water Supply. J. Spotteswoode Cameron. Cites examples of unintentional fouling of water not easily controlled, unless the city has the absolute ownership of the basin. Discussion. 4500 w. Jour of San Inst—Jan., 1899. No. 25780 F.

Chattanooga.

The Water-Works Question in Chattanooga. Reviews the expediency of building public works when a private company having a good plant offers to sell its works, or to allow a board of arbitrators to establish a schedule of charges. 600 w. Eng Rec—Feb. 4, 1899. No. 25742.

Denver, Colo.

Denver and Its Water System. Brief account of the water supply of this city. 1200 w. Fire & Water—Feb. 4, 1899. No. 25785.

Electrolysis.

A Test for Electrolysis of the Jersey City Water Conduits. Gives extracts from report of A. A. Knudson, describing the method of making the test, and giving a sketch showing the course which the current took to return to the power-house. 1200 w. Eng News—Feb. 2, 1899. No. 25707.

Electrolysis in Jersey City. Illustrated report of an unusual instance of injuring the pipes by current from electric railways. 2000 w. Eng Rec—Feb. 11, 1899. No. 25847.

Filtration.

A Discussion on Filtration. Report of discussions by George W. Fuller and Allen Hazen on sand and mechanical filtration, and the turbidity of streams. 900 w. Eng Rec—Feb. 11, 1899. No. 25852.

The Report of the Pittsburg Water Filtration Commission. An abstract of a report as yet unpublished, favoring a combined system of sedimentation and slow sand filtration, and of a thorough meter system to lessen the waste. 5500 w. Eng News—Feb. 23, 1899. No. 26152.

Water Filtration Experiments, Pittsburg, Pa. A review of the experiments begun in June, 1897, to determine the best method of supplying pure water to Pittsburg. Gives results of experiments with sand and mechanical filters and sedimentation basins and similar data. 5600 w. Eng Rec—Feb. 11, 1899. No. 25846.

Fire Protection.

Fire Protection for High Buildings. Abstract of the opinions of engineers and other experts on the general need of fire protection, as given at the hearing before the Aldermen's committee and the building department of New York. 1200 w. Fire & Water—Feb. 4, 1899. No. 25784.

Fire Streams.

A Photographic Study of Fire Streams. A Marston. Abstract of paper presented at the recent meeting of the Iowa Engng. Soc. Illustrated description of the results of an investigation of fire streams, conducted with a number of ring and smooth nozzles, in which the streams were photographed, as well as measured in the usual manner. 2000 w. Eng Rec—Feb. 18, 1899. No. 26115.

London.

London Water Supply. Editorial on the report just issued by the Royal Commission on Water Supply. 3500 w. Engng—Jan. 27, 1899. No. 25794 A.

London's Underground Source of Water Supply. Reports the probability of a natural subterranean reservoir under the city, with a capacity sufficient to supply a daily yield of 7065 million gallons. Also an account of the supply of London three hundred years ago. 1300 w. Fire & Water—Jan. 28, 1899. No. 25604.

The Intercommunication Scheme of the London Water Companies. Text of the portion of the recently issued interim report of the Royal Commission on the Metropolitan Water Supply, which refers to the three schemes for the intercommunication of the different systems. 1000 w. Jour Gas Lgt—Feb. 7, 1899. No. 25998 A.

The London Water Supply. Arthur Shadwell. An answer to an article by Mr. Shaw Lefevre, published in the Dec. number of this Review. 6600 w. Ninteenth Cent—Feb., 1899. No. 26197 D.

Philadelphia.

Plain Talk from a Water-Works Manager. A résumé of the report of the chief of the Philadelphia water-bureau concerning the result of the failure to provide money for repairs and improvements. 3000 w. Eng Rec—Feb. 11, 1899. No. 25850.

Reservoir.

A New High-Service Reservoir, Haverhill, Mass. Illustrated description of a 9,000,000 gal. reservoir in which the bank has a peculiar concrete lining. 1300 w. Eng Rec—Feb. 25, 1899. No. 26184.

Stand-Pipe.

Standpipe with Brick Casing at Racine, Wis. Illustrated description of a brick casing built around an elevated tank to prevent freezing and injurious strains from wind. 1400 w. Eng Rec—Feb. 18, 1899. No. 26116.

Venturi Meter.

The Venturi Meter. Report of the Committee on Science and the Arts on the inventions of Clemens Herschel, Frederick N. Connet and Walter W. Jackson. This meter is designed for the measurement of the flow of liquids in pipes of large dimensions. Ill. 8400 w. Jour Fr Inst—Feb., 1899. No. 25775 D.

Water Analysis.

I. Recent Progress in the Methods of Water Analysis. Clarence A. Seyler. (Abstract). II. Interpretation of Results of Water Analysis. Sidney Barwise. The standard methods and results are discussed, and the need of more than a single chemical analysis. Discussion. 6500 w. Jour of San Inst—Jan., 1899. No. 25782 F.

Water Mains.

Carrying a 30-in. Water Main Over and Through a Masonry Arch Bridge at Hartford, Conn. E. D. Graves. Brief extract from paper read before the Conn. Soc. of Civ. Engs. & Surv., with drawings and view showing details of a novel method. 350 w. Eng News—Feb. 23, 1899. No. 26151.

Movement of Water-Mains in Connection with Pennsylvania Avenue Subway Work. Allen J. Fuller. An account of the changes made necessary by the subway and the relaving of the mains. Ill. 1300 w. Pro of Eng' Club of Phila—Jan. 1899. No. 26,126 D.

Water Softening.

Water Softening at Southampton, England. James H. Fuertes. Illustrated description of a plant which reduces the hardness of 4,000,000 gals. daily from 18 to 5 degrees. 2400 w. Eng Rec—Feb. 4, 1899. No. 25746.

Water Tower.

The New Water Tower for the Towns of Mulheim, Deutz and Kalk. (Der Neue Hochbehälter des Wesserwerkes für die Städte Mülheim a-Rh., Deutz, und Kalk.) F. Thometzek. A description of the manner in which the capacity of a water tower was increased by the erection of a second tank above the original one. Detail drawings are given. 1000 w. 1 plate. Zeitschr d Ver Deutscher Ing—Jan. 28, 1899. No. 26065 D.

Water-Works.

The Gainsborough Water-Works. A brief explanation of the scheme for extending these works, and the vicissitudes through which it has passed, with an account of the recovery of a boring tool that was lost at a depth of 725 feet, on April 1, 1897. 1300 w. Jour Gas Lgt—Feb. 7, 1899. No. 25997 A.

We supply copies of these articles. See introductory.

York Supply.

The Reconstruction of the York, Pennsylvania, Water-Supply. John Birkinbine. Describes the method followed in correcting defects in a reservoir, and also the present plant. 4500 w. Pro of Engs' Club of Phila—Jan., 1899. No. 26128 D.

MISCELLANY.

Artisans' Dwellings.

The Erection of Artisans' Dwellings by Municipal Corporations. Describes this question in its relation to London and Glasgow, and concludes the city is not justified in erecting dwellings at a cost at which profitable results are not obtained. 2000 w. Builder—Jan. 28, 1899. No. 25824 A.

Franchises.

Franchises, Robert E. McKisson. Address at Zanesville, O., before the Ohio Municipal League. Discusses the need of correcting the abuses of franchises in American cities, favoring municipal ownership of water and lighting plants. 1600 w. Pro Age—Feb. 15, 1899. No. 25945.

Heat of Cities.

Vegetation a Remedy for the Summer Heat of Cities. Stephen Smith. A plea for the cultivation of trees, shrubs, plants, vines, and grasses in the streets of New York, for the improvement of the public health, for the comfort of summer residents, and for ornamentation. 7000 w. Ap Pop Sci M—Feb., 1899. No. 25666 D.

Municipal Co-operation.

Municipal Co-operation a Possible Substitute for Consolidation. Refers to the experience of Boston and Newark, and their suburbs, as cases of municipal co-operation, and the advantages of consolidation, as represented by Greater New York, favoring co-operation. 3000 w. Eng News—Feb. 16, 1899. No. 25970.

Municipal Enterprise.

Municipal Factories. Editorial discussion of the functions to be undertaken by public bodies, and the absurdity of modern socialistic theories. 2200 w. Engng—Feb. 10, 1899. No. 25983 A.

The Cost of Municipal Enterprise. Dixon H. Davies. An interesting consideration of this subject favorable to private companies, and presenting the disadvantages and dangers attending municipal enterprise. Also discussion. 11200 w. Jour Soc of Arts—Feb. 3, 1899. No. 25898 A.

Municipal Socialism.

Municipal Functions: A Study of the Development, Scope and Tendency of Municipal Socialism. Milo Roy Maltbie. A study of what the municipality does; discussing the historic development; the scope of present municipal activities, and the future outlook. 60000 w. Munic Af—Dec., 1898. No. 25877 E.

Refuse Disposal.

Refuse Disposal at Barren Island, New York. Reviews the report of Dr. E. L. Martin, J. B. Taylor and John Bogart on the nature and offensiveness of the plants where the garbage and dead animals of New York are converted into fertilizers and soap grease. 2000 w. Eng Rec—Feb. 4, 1899. No. 25749.

The Utilization of City Refuse in Boston, Mass. Illustrated description of a plant for sorting the combustible refuse of the city and burning the useless portions. 1800 w. Eng Rec—Feb. 25, 1899. No. 26186.

RAILWAY AFFAIRS

CONDUCTING TRANSPORTATION.

Accident.

The Accident on the London and Northwestern Railway at Penmaenmawr. Brief illustrated description. 300 w. Engng—Jan. 20, 1899. No. 25613 A.

Train Accidents in the United States in December. Detailed list, with classified summary and additional information. 4400 w. R R Gaz—Feb. 3, 1899. No. 25732.

Employees.

The Discipline and Education of Railway Employees. George R. Brown. Concerning the success of the Brown System of Discipline, which has been adopted by fifty-three American railways. 2200 w. Am Eng & R R Jour—Feb., 1899. No. 25649 C.

Fast Mail.

A New Fast Mail Train Across the United States. An account of the first run of the train which has shortened the time between New York and San Francisco by twelve hours, and the proposed reduction of twenty to twenty-four hours. 1500 w. Engr, Lond—Feb. 10, 1899. No. 25979 A.

Fast Trains.

London to Brighton in an Hour. Charles Rous-Marten. An account of the running of a Pullman car express from Victoria Station to Brighton, with description of the train, service, etc. 1600 w. Engr, Lond—Jan. 27, 1899. No. 25810 A.

FINANCIAL.

Central Pacific.

The Central Pacific Settlement and Readjustment. On the plan for the readjustment of the corporation's finances as agreed upon. 900 w. Bradstreet's—Feb. 25, 1899. No. 26194.

Earnings.

Gross Railway Earnings Still Growing. Gains shown in earnings over the same month a year ago. 1000 w. Bradstreet's—Feb. 11, 1899. No. 25873.

Net Railroad Earnings in 1898. Discusses some of the causes that have affected the earnings of railroads of the United States in recent years, giving tabulated statement of gross and net earnings for twelve months ending in Dec. 1000 w. Bradstreet's—Feb. 18, 1899. No. 25955.

MOTIVE POWER AND EQUIPMENT.

Auxiliary Railways.

Light Railways in France. Illustrations and information of the subsidiary system affiliated to that of the Western Railway of France. Also describes the type of locomotives used. 1000 w. Engng—Jan. 20, 1899. No. 25611 A.

Cars.

80,000 Lbs. Capacity Cars for the Cleveland, Cincinnati, Chicago and St. Louis. Brief illustrated description. 400 w. R R Gaz—Feb. 17, 1899. No. 25946.

Coal Consumption.

Comparative Coal Consumption of Simple and Compound Locomotives. Observations and records taken on the La Crosse Division of the Chicago, Milwaukee & St. Paul R. R. 400 w. R R Gaz—Feb. 10, 1899. No. 25875.

Disinfection.

The Thorough Disinfection of Railway Cattle Cars. (Die Wirksame Desinfection der beim Thiertransporte Verwendeten Eisenbahnwagen. Adolf Freund. A description of the methods adopted in various parts of Germany for the prevention of the spread of contagious diseases in the railway transport of cattle. Two articles. 10,000 w. Zeitschr d Oesterr Ing u Arch Ver—Jan. 13, 20, 1899. No. 26052 each B.

Electric Locomotives.

The Electric Locomotive of the Paris-Lyons-Mediterranean Company. (Locomotive Electrique de la Cie P.-L.-M.) A very complete account of the high-speed express locomotive of the P. L. M. Railway in France. Speeds of 60 miles per hour, with a train of 100 tons, were attained; storage batteries of the Fulmen type being employed. 4500 w. Energie Electrique—Jan. 1, 1899. No. 26035 D.

The Electrical Locomotive of the Paris, Lyons & Mediterranean Railroad. Illustrates and describes the locomotive, giving the results obtained on the main line between Paris and Melun. 2000 w. Elec Wld—Feb. 4, 1899. No. 25688.

The Storage Battery Locomotive of the P. L. M. Railway, France. From La Nature. Illustrated description. 700 w. Elec Eng, N. Y.—Feb. 23, 1899. No. 26167.

Freight Cars.

Building 15 Freight-Cars per Day—Chicago, Milwaukee and St. Paul Railway. Describes the plan by which this creditable performance is carried on. The record was not broken from the middle of Jan., 1898, to the 6th of June. Ill. 2000 w. Eng & R R Jour—Feb., 1899. No. 25650 C.

Head-Light.

Electric Arc Lamp for Locomotive Head-Light. (Elektrische Bogenlichtstirnlampe für den Fahrdienst auf Eisenbahnen.) Max Schiemann. A description of the Wagenhals lamp and an account of its performance, with data as to cost of maintenance. 2500 w. Elektrotech Zeitschr—Jan. 19, 1899. No. 26069 B.

Locomotive Boilers.

The Loss of Heat from Locomotive Boilers. An account of the most elaborate series of tests ever undertaken to measure the loss of heat under the conditions of service. Also editorial. Abstract of report of tests given at meeting of Western Ry. Club, by Robert Quayle. 5400 w. Eng News—Feb. 23, 1899. No. 26149.

Locomotives.

Consolidation Locomotive, L. I. R. R. Halftone view and side, rear and sectional elevations of locomotives constructed for the Long Island Railroad, with dimensions. 500 w. Ry & Engng Rev—Feb. 11, 1899. No. 25892.

Consolidation Locomotives for the Oregon Railroad & Navigation Co. Illustrated description giving dimensions. 600 w. R R Gaz—Feb. 3, 1899. No. 25731.

Diagrams of Runs by French Engines. Representing in graphic form the performances of two different classes of French engines described in the articles by Charles Rous-Marten. 200 w. Engr, Lond—Jan. 20, 1899. No. 25631 A.

Eight-Wheel Passenger Locomotive, F. C. & P. R. R. Illustrated description, with dimensions. 500 w. Ry & Engng Rev—Feb. 18, 1899. No. 26132.

Express Passenger Locomotive for the Belgian State Railways. Illustrated detailed description, with dimensions. Two-page plate. 1000 w. Engng—Feb. 3, 1899. No. 25908 A.

Grates, Ash Pans and Dampers for Anthracite and Bituminous Coal Locomotives. Illustrates and explains the practice of the Pennsylvania Railroad. 900 w. Am Eng & R R Jour—Feb., 1899. No. 25651 C.

New Compound Locomotives for the Austrian State Railways. (Les Nouvelles Locomotives Compound de la Compagnie des Chemins-de-Fer de l'Etat Autrichien.) With illustrations and specifications of the various types of engines, all of the two-cylinder compound design. 1200 w. Le Génie Civil—Feb. 4, 1899. No. 26008 D.

Specifications of a Four-Wheel Coupled Passenger Engine—Great Northern Railway, Ireland. A copy of the specification in full, with working drawing. 4200 w. Engr, Lon—Jan. 20, 1899. No. 25634 A.

The Evolution of the Locomotive Engine. William P. Marshall. Extracts from a recent paper before the Institution of Civil Engineers, relating to important changes in the details of English locomotives. 1800 w. R R Gaz—Feb. 24, 1899. No. 26175.

Rating.

Tonnage Rating for Locomotives. Reports the tests made on the Peoria & Eastern Div. of the C., C., C. & St. L. Ry., to determine the maximum number of tons that could be hauled in each direction up all the ruling grades. 1500 w. R R Gaz—Feb. 17, 1899. No. 25949.

Resistance.

A New General Formula for Train Resistance. Gives a general formula which the editor says appears to be applicable to passenger trains of all weights, running at all speeds. Worked out by John Lundie as a result of a long series of tests of trains in actual service. 1700 w. St Ry Jour—Feb., 1899. No. 25726 D.

A New Train Resistance Formula. Editorial criticism of the Lundie formula given in the Street Railway Journal for February. 2400 w. R R Gaz—Feb. 17, 1899. No. 25951.

Train Resistance. Editorial discussion of formula of John Lundie, given in the Street Railway Journal. 800 w. Engng—Feb. 10, 1899. No. 25984 A.

Rolling Stock.

Modern Rolling Stock. Abstract of paper presented by W. McIntosh at the Dec. meeting of the Northwest Ry. Club. Asserts that a track and road-bed that will carry locomotives of 100 tons and cars of 50 tons capacity will soon be necessary. 1200 w. R R Gaz—Feb. 17, 1899. No. 25950.

The Shortage of Rolling Stock. From the London Railway Times. A statement of conditions in Great Britain, especially in reference to coal transportation, and the difficulty in solving the problem. 1400 w. Col Guard—Feb. 3, 1899. No. 25916 A.

Springs.

Underhung Driving Spring Rigging. L. R. Pomeroy. Calls attention to the difficulties that may arise in the changed conditions and their remedy. Ill. 700 w. Am Eng & R R Jour—Feb., 1899. No. 25652 C.

NEW PROJECTS.

Great Central Ry.

The Great Central Railway. A description of this important addition to the English railway system, with map indicating route. 4800 w. Engng—Feb. 10, 1899. Serial. 1st part. No. 25982 A.

The Great Central Railway from Annesley to Nottingham. An illustrated account of the construction and route, and the buildings, etc. 3300 w. Engr, Lond—Feb. 3, 1899. No. 25918 A.

Improvements.

South Eastern Railway Improvements. On changes being made in the widenings, stations, etc., of this English railway. 1500 w. Engr, Lond—Feb. 10, 1899. No. 25975 A.

Japan.

The Railways of Hokkaido, Japan. S. Tanabe. Brief account of the extent, population, etc., of the island, with a short physical description of the new lines constructed and surveyed. Ill. 800 w. Eng News—Feb. 23, 1899. No. 26148.

Little Railways.

Little Railways for South African Colonies. Editorial discussion of the conditions prevailing in these colonies, and the advisability of constructing a 2-ft. gauge line. Considers the views of C. Bodtker, given in a recent pamphlet. 2000 w. Engng—Jan. 20, 1899. No. 25615 A.

Phillipines.

Railroading in the Philippines. A description of the single railroad line in these islands, the equipment, and the country through which it passes. 1800 w. Sci Am—Feb. 25, 1899. No. 26155.

Siberia.

Notes from the Statistics of the Siberian Railway. (Einige Mittheilungen aus den Statischen Veröffenlichungen der Siberischen Eisenbahn.) An abstract of the reports upon the cost of the Trans-Siberian railway from 1893 to 1897, giving data as to progress and cost of the work. 1800 w. Glasers Annalen—Feb. 1, 1899. No. 26046 D.

The Railways of Siberia and Eastern China. (Les Chemins de Fer de Sibérie et de l'Est de la Chine.) R. de Batz. An excellent account of the present condition of the work on the Trans-Siberian Railway and its connection with the Eastern Railway of China, with map and numerous views of stations. 3000 w. Le Génie Civil—Jan. 21, 1899. No. 26001 D.

The Trans-Siberian Railway. Its immediate prospects. Extracts from an essay by M. Belinski, in the Russki Vestrick are given, and comments. 800 w. Engr, Lond—Jan. 20, 1899. No. 25629 A.

The Trans-Siberian Railway and the Coal Resources of Siberia. Considers this new line and its economic results, and the various coal fields that it will open. Map and Ill. 4000 w. Ir & Coal Trds Rev—Jan. 27, 1899. No. 25808 A.

Single Rail.

The Proposed Lightning Express Railway Between Liverpool and Manchester. Proposing to construct and work a railway on this system which will enable passengers to travel between Liverpool and Manchester in eighteen minutes. 1200 w. Transport—Jan. 20, 1899. No. 25639 A.

PERMANENT WAY AND FIXTURES.

India.

Railway Location and Surveys in Rajputana, India. C. H. Croudace. A beautifully illustrated paper upon the work on the location of the Delhi-Karachi direct line through the sand-ridge district in Northern India. 4000 w. Engineering Magazine—March, 1899. No. 26092 B.

Oneonta Shops.

Delaware & Hudson Shops at Oneonta. Illustrates and describes the appliances used in these shops, giving also a brief description of the buildings. 2500 w. R R Gaz—Feb. 3, 1899. No. 25733.

Roadmasters.

Civil Engineers for Maintenance of Way. Jerry Sullivan. The writer does not consider that the education as a civil engineer equips a man for the position of roadmaster. The duties he may be called upon to perform are stated, and the training needed. 2700 w. Ry & Engng Rev—Jan. 28, 1899. No. 25605.

Signals.

Inspection of and Repairs to Automatic Block Signals. W. A. D. Short. Read before the Ry. Signaling Club of Phila. Discusses the distribution of labor, and what should be required of inspectors, the methods, etc. 1200 w. R R Gaz—Feb. 24, 1899. No. 26171.

Railway Signaling. Charles Hansel. Considers the most approved methods of guarding against collisions, signaling on single track, protection of grade crossings and junctions, etc., with discussion. Ill. 15000 w. N Y R R Club—Jan. 19, 1899. No. 25931.

The Distant Signal. E. D. Wileman. Abstract of a paper presented at the Philadelphia meeting of the Railway Signaling Club. Outlines a satisfactory installation at a very difficult location, and discusses various types of distant signal. 2200 w. Eng News—Feb. 23, 1899. No. 26150.

Station.

New Passenger Station at Quincy, Ill.; C., B. & Q. R. R. Plan and elevation are given, with description. 500 w. Eng News—Feb. 16, 1899. No. 25969.

Subway.

Pennsylvania Avenue Subway and Tunnel. George S. Webster. A description of the work of abolishing seventeen grade-crossings of the Phila. & Reading Ry., on the line of Pennsylvania Ave., in the city of Philadelphia. Ill. 4800 w. Pro of Engs' Club of Phila.—Jan., 1899. No. 26125 D.

The Passy Subway. (Le Souterrain de Passy.) A. da Cunha. With illustrations of the progress of the work, and a map showing the line, as well as the covered and uncovered parts of the subway now under construction in Paris. 2500 w. La Nature—Jan. 28, 1899. No. 26028 B.

Track.

Broad Flanges vs. Tie Plates. Editorial discussion of an article by C. P. Sandberg, indexed from London Engineering, on the advantage of using heavier rails for railways laid with flange rails. 1800 w. R R Gaz—Feb. 10, 1899. No. 25876.

Track Elevation.

Track Elevation in Chicago. Four illustrated papers of track elevation and depression in Chicago, with discussion. The papers are by W. H. Coverdale, H. W. Parkhurst, G. W. Vaughn, and Marvin H. Dey. 14000 w. Jour W Soc of Engs—Dec., 1898. No. 25674 D.

Zurich.

The New Railway Station at Zurich. (La Nouvelle Gare de Zurich.) MM. Berquet & Margot. A general description of this new terminal, providing accommodations for eight railways. 2000 w. 1 plate. Rev Gen des Chem de Fer—Jan., 1899. No. 26029 F.

TRAFFIC.

Cheap Rates.

Passenger Classification. William G. Raymond. A comparison of statistics, as furnished by the Interstate Commerce Commission, as an argument for reducing rates. 2000 w. R R Gaz—Feb. 10, 1899. No. 25874.

German Railways.

A Review of the Work of the Union of German Railway Administrations. Alex Bewley. An account of the remarkable work accomplished by this association. 3500 w. Ind Engng—Jan. 21, 1899. No. 26111 D.

STREET AND ELECTRIC TRAMWAYS

Accumulators.

Storage Batteries and Railway Power Stations. Robert McA. Lloyd. Abstract of a paper read before the Am. Inst. of Elec. Engs. The application of the storage battery to electric railway operation is discussed, and the advantages shown. 3500 w. Eng News—Feb. 23, 1899. No. 26153.

The Use of Accumulators in Tramway Driving. (Bahn-Betrieb mit Accumulatoren.) A paper before the German Railway Society, discussing the advantages of storage batteries for equalizing the load upon the power plant. 5000 w. Glasers Annalen—Feb. 1, 1899. No. 26045 D.

American Tramways.

Street Railway Mileage, Cars and Capitalization in America. Tabulated statement, giving a compilation of the electric, cable and horse railways of the United States and Canada. St Ry Jour—Feb., 1899. No. 25728 D.

Argentine Republic.

Electric Railroading in the Argentine. Illustrated description of the electric lines of Buenos

Aires. 1800 w. St Ry Jour—Feb., 1899. No. 25723 D.

Ball Bearings.

The Application of Ball Bearings to Tramways. (Anwendung von Kugellagern bei Strassenbahnen.) R. v. Podoski. With illustrations of the bearings used on various Swiss tramways, and very full data of traction tests, with numerous diagrams. Two articles. 6000 w. Elektrotech Zeitschr—Jan. 26, Feb. 4, 1899. No. 26072 each B.

Boston Subway.

The Boston Subway. An interesting illustrated description of this great engineering work, and the advantage it has already proved to the much congested traffic. 5500 w. Elec Wld—Feb. 11, 1899. No. 25890.

Electric Locomotive.

See Railway Affairs, Motive Power.

Electric Railroads.

Electric Street Railroads in England. Outlines the evidences of a great awakening in England in the use of electricity, and the chances for American manufacturers and contractors in connection with the work. 2800 w. U. S. Cons Repts, Vol. LIX., Feb., 1899. No. 25664 D.

Electrical Traction.

Power Distribution for Electrical Traction. Ernest Wilson. Remarks on power distribution in general, with an examination of present practice of delivering the energy to the cars. 4000 w. Engr, Lond—Jan. 20, 1899. No. 25627 A.

Some General Observations on Electric Traction. Horace F. Parshall. Read before the Northern Soc. of Elec. Engs. Discusses the steam generating plant, speed of engines, system of transmitting, and various matters relating to the designing and working. Brief report of discussion. 4000 w. Ind & Ir—Jan. 27, 1899. No. 25814 A.

Electrolysis.

See Municipal Engineering, Water Supply.

Fares.

Methods for Collecting and Registering Fares on Interurban Lines. F. H. Fitch. The problem of collection and registration of fares is discussed, with description of form designed by the writer. 1800 w. St Ry Rev—Feb. 15, 1899. No. 25959 C.

Glasgow.

The Glasgow Corporation Electric Tramways. Part first explains why electric traction was adopted, and describes the construction of the line. Ill. 3800 w. Engr, Lond—Feb. 10, 1899. Serial. 1st part. No. 25978 A.

Higher Voltage.

Notes on Higher Voltage Trolley Wires. Ernest Kilburn Scott. Notes on raising the voltage of trolley lines as an expedient when tram lines extend great distances from the power station. 1500 w. Elec Rev, Lond—Feb. 10, 1899. No. 25991 A.

Interurban.

The Detroit, Ypsilanti, and Ann Arbor Interurban Electric Railway. Illustrates and describes the road and its equipment. 1000 w. Elec Eng, N. Y.—Dec. 22, 1898. No. 24670.

The Interurban Electric Railways Around Detroit. An illustrated detailed description of an extended system of these railways. Also editorial. 5000 w. St Ry Jour—Jan., 1899. No. 25031 D.

The Wilkes-Barre Interurban Railway. Illustrates and describes an interesting line, extending from Luzerne, Pa., to Harvey's Lake, which has proved successful where a steam line failed. 1300 w. St Ry Rev—Feb. 15, 1899. No. 25964 C.

Joint.

The Falk Joint. (Joints Falk.) An account of the Falk cast rail joint for electric tramways, as applied in France, with illustrations from photographs of the pouring of the metal. 3000 w. 1 plate. La Revue Technique—Jan. 10, 1899. No. 26015 D.

Jungfrau.

The Jungfrau Railway. (Le Chemin de Fer de la Jungfrau.) R. Godfernaux. A general description of the three-phase electric rack railway now under construction to the summit of the Jungfrau, in Switzerland, with topographical map. 4000 w. Rev Gen des Chem de Fer—Jan., 1899. No. 26030 F.

The Jungfrau Railway. Views of the section just opened, with reports, by various authorities, upon the project. 2800 w. Engr, Lond—Feb. 10, 1899. Serial. First part. No. 25974 A.

Madrid.

Madrid Electric Tramways. An illustrated detailed account of these tramways, with a brief sketch of the city. 3000 w. Ry Wld—Feb. 9, 1899. No. 25996 A.

Materials.

Purchase, Inspection and Distribution of Street Railway Material and Supplies. H. W. Brooks. Review of a paper and discussion presented at the meeting of the New York Railroad Club, Oct. 20, 1898, with application to street railway practice. 3700 w. St Ry Rev—Feb. 15, 1899. No. 25961 C.

Paris.

The Metropolitan Railway of Paris. (Le Métropolitain de Paris.) G. Leugny. An account of the present state of the work, with plans showing the arrangement of the tunnels at important intersections and terminals. 3000 w. La Revue Technique—Jan. 10, 1899. No. 26016 D.

Pittsburg.

New Power Station, Shops and Pleasure Resort of the Consolidated Traction Company, Pittsburg. Description and illustrations. 4500 w. St Ry Rev—Feb. 15, 1899. No. 25965 C.

Power.

The Computation of the Power Required for Electric Street Railways. (Berechnung des Kraftbedarfes von Elektrischen Strassenbahnen.) Ludwig Schroeder. A discussion of the graphical method of plotting the varying demands for power, showing the use of accumulators for equalizing the load upon the motive power. 6000 w. Elektrotech Zeitschr—Feb. 2, 1899. No. 26078 B.

Public Relations.

The Street Railway as a Public Institution and Its Relations to the Public. H. H. Windsor. Extracts from an address before the Political Economy Club, Univ. of Chicago. 8000 w. St Ry Rev—Feb. 15, 1899. No. 25962 C.

Roadway Department.

Roadway Department of the Union Traction Company, Philadelphia. Describes the practice of this department ,and the appliances used. Ill. 2200 w. St Ry Jour—Feb., 1899. No. 25725 D.

Snow.

Snow-Bound Street Car Systems. William Herbert Donner. Suggestions for keeping lines open, and details concerning the management. 900 w. Am Elect'n—Feb., 1899. No. 25831.

Street Railways.

The Relation of the Street Railway to the Public. James F. Lardner. Extract from a paper read before the Contemporary Club. The extract given refers to the price of a ride, and the giving more for the money, the value of franchises, etc. 1500 w. St Ry Rev—Jan. 15, 1899. No. 25371 C.

Switzerland.

The Stausstad-Engelberg Electric Railway. Illustrated detailed description of an electric line connecting this village, Lake of Lucerne, with a favorite tourist's resort. 2200 w. Elect'n, Lond—Jan. 27, 1899. No. 25818 A.

Book Reviews

SANITARY ENGINEERING. By Wm. Paul Gerhard, C. E., Author and Publisher NewYork, 1898. ELEMENTS OF SANITARY ENGINEERING By Prof. Mansfield Merriman. New York: John Wiley & Sons. London: Chapman & Hall, 1898.

It is not often that two books are offered for review at the same time, which deal with the same subject and which offer greater opportunities for comparison than do "Sanitary Engineering" and "Elements of Sanitary Engineering." They not only offer opportunities but they demand a comparison, in making which we shall follow the law, "For the last shall be first and the first shall be last."

In a foot-note, we are told by Mr. Gerhard that 101 pages of this book comprise a lecture which was delivered before the Franklin Institute, on Feb. 15, 1895, and in another foot-note that the rest of the 132 pages is reprinted from the *Sanitarian*, of June, 1895; a third foot-note tells us that the author and publisher has at least a quoting acquaintance with "Lucile" and that he (the author and publisher) agrees with one of the statements made by "Owen Meredith," which statement, however, has nothing whatever to do with sanitary engineering. This fact is entirely consistent with the rest of the book, since in it we find very little that has to do with sanitary engineering and we are forced to one of three conclusions: 1. Sanitary engineering must still have been only a name and not yet a thing, in 1895. 2. The author and publisher may not have been well acquainted with the subject. 3. The author and publisher may have a low opinion of his audience.

There is no more doubt as to the value of Prof. Merriman's work than there is concerning the futility of publishing such slip-shod inanities as are contained in the book brought out by Mr. Gerhard.

Prof. Merriman begins with an interesting statement of what sanitary engineering really is, its professional limits and its cognate branches. Historical notes, the classification of diseases, statistics of mortality, bacteriology, organic matter, filth and disease, impure air and disease, drinking water and disease, matter in natural waters, chemical analysis of water, biological analysis of water, interpretation of analysis and finally, the results of sanitary science, which completes Chapter I. and page 46.

Chapter II. deals with Water and its Purification, Chapter III. with Water Supply Systems, Chapter IV. with Sewerage Systems and Chapter V. with the Disposal of Garbage and Sewage.

Since the book is partly intended for students, a series of problems or exercises follows each chapter: from those appended to Chap. I., which in all number 25, we abstract two: "5. Give sketches showing the characteristic forms of the three classes of bacteria. What is the name of the germ that causes typhoid fever?" "10. Consult Part 1, of Experimental Investigations by the State Board of Health of Massachusetts (Boston, 1890), and give an account of the work for determining the normal chlorine in that State."

To city engineers and all those who are employed or interested in city matters, we believe that the work will be of immense value, not wholly for what it will teach them in exact knowledge, although that will be much, but because a single reading of it is enough to show the absolute necessity of technical advice in what concerns the water-supply, street-cleaning and garbage disposal of cities and even small towns. "Large oaks from little acorns grow," small towns in time become cities, and the mistakes of the youth cause the death of the man. The right time to start a system of sewage disposal is during the village state and if a small community takes its drinking water from an impure source, the error is likely to be perpetuated. Therefore, it seems that it is not so necessary to create sanitary engineers as to create a wide demand for them and it is in performing the latter function that we hope the most from this book.

NEW CATALOGUES AND TRADE PUBLICATIONS

These catalogues may be had free of charge on application to the firms issuing them. Please mention The Engineering Magazine when you write.

Risdon Iron Works, San Francisco, Cal., U. S. A.—Handsomely illustrated catalogue of gold dredging machinery, showing numerous applications of methods of sub-aqueous mining by the use of the Risdon gold dredge. The applicability of the machine for dredging on banks, in rivers and other locations is well shown. The catalogue also contains useful information about apparatus and methods of hydraulic mining.

Merchant & Co., Philadelphia, Pa., U. S. A.—Neatly printed little pamphlet entitled "How Roofing Tin Is Made," giving descriptions of the cheap acid-flux process and the high-grade, palm-oil flux method, and showing the advantages of the latter method, used by the writers for the production of various brands of high-grade roofing plate.

Queen & Co., Philadelphia, Pa., U. S. A.—Fully illustrated pamphlets consisting of (*a*) a manual of engineers' and surveyors' instruments, giving very complete accounts of the high-grade transits, theodolites, levels and other instruments, with much valuable information relating to adjustments, care and use; and (*b*) a manual of practical draughting, forming a useful hand-book to the use of drawing instruments.

The Grant Machine Tool Works, Cleveland, Ohio, U. S. A.—Catalogue of fine machine tools, including lathes, boring machines and milling machines and accessories, also list of balls of steel and other hard metal for ball bearings.

Detroit Graphite Manufacturing Company, Detroit, Mich., U. S. A.—Handsome catalogue describing the nature and merits of the Superior Graphite Paint for the protection of metal work from corrosion. Many illustrations of buildings and other structures upon which the paint has been used are given.

Andrew J. Corcoran, Jersey City, N. J., U. S. A.—Finely illustrated catalogue of the Corcoran windmill, as adapted for pumping water, showing many installations on handsome estates in various parts of the United States. Excellent indorsements from a number of prominent users are given.

Sprague Electric Company, New York.—Architects' and engineers' bulletin, containing much useful and valuable information concerning automobiles, surface-contact electric railways, electric motors, electric heating, interior wiring and other matters of interest. The typography and illustrations are particularly worthy of commendation.

Fraser & Chalmers, Chicago, Ill., U. S. A.—Catalogue No. 34, describing and illustrating the Sederholm boiler, especially intended for high pressures and large units. Valuable tables of the properties of saturated steam, of evaporation factors, and other useful matter are given.

The C & C Electric Company, New York.—Bulletin No. 128, with illustrations and specifications of four, six and eight pole dynamos, arranged either for direct connection to engine shaft or for belt driving. Details of foundations and of parts are also given.

The Hoppes Manufacturing Company, Springfield, Ohio, U. S. A.—Catalogue of the Hoppes steam separators, oil eliminators and feed-water heaters. Various forms of separators are shown for different locations, and details of dimensions and prices of the various sizes given.

Nicholson File Company. Providence, R. I., U. S. A.—File Filosophy, containing many useful hints and instructions about the proper use of files, and forming a reprint of the most important portions of Mr. William T. Nicholson's treatise on files, now out of print.

Baldwin Locomotive Works, Philadelphia, Pa., U. S. A.—Record of recent construction, No. 10, January, 1899. Contains illustrations and specifications of locomotives recently built by this firm for many parts of North and South America, and for Russia. Special attention is called to the locomotive of the Forney type for the Cauca Railway of the United States of Colombia for 4 per cent. grades and curves of 200 feet radius.

J. H. Williams & Co., Brooklyn, New York, U. S A.—Catalogue of drop forgings of iron, steel, copper, bronze and aluminum, with illustrations and price lists of wrenches, crank handles, eyebolts, machine parts, bicycle forgings and golf club heads.

The Hohmann & Maurer Manufacturing Company, Rochester, N. Y., U. S. A.—Pamphlet containing illustrations of various forms of thermometers for industrial uses, with comments and testimonials from users.

Buffalo Forge Company, Buffalo, N. Y., U. S. A.—Small catalogue of the Buffalo down-draft forges with down-draft exhaust hoods for removing the smoke as it is generated.

Reeves Pulley Company, Columbus, Ind., U. S. A.—Large catalogue of the Reeves variable speed countershaft, showing its adaptability to overhead countershafts for machine-tool driving, and also to the control of speed of mechanically propelled vehicles.

Fred M. Locke, Victor, N. Y., U. S. A.—Illustrated catalogue of porcelain and glass insulators for high voltage electric power transmission. Insulators for a great variety of work are shown, and a list of users on long-distance power transmission in many parts of the United States, as well as in Mexico, South America, Japan and Siam, are given.

Graham, Morton & Co., Limited.—Black Bull St., Leeds, England.—Illustrated catalogue of conveying plant and power transmission machinery; also of hydraulic pressed colliery tubs, gas and chemical plant, coal-washing machinery and structural iron work.

Marshall, Sons & Co., Limited, Gainsborough, England.—*(a)* Steam engine and boiler catalogue, describing and illustrating a full line of portable and stationary engines, boilers, etc., with price list. *(b)* Illustrated description of the firm's works.

The Brush Electrical Engineering Company, Limited, 49 Queen Victoria St., London, E. C.—Cloth bound illustrated catalogues *(a)* of alternators, dynamos, motors, the Universal steam engine and electrical accessories; *(b)* of locomotives. tram cars and goods wagons. The information given is most complete.

Rosling & Appleby, Trafalgar Works, Bradford, England.—*(a)* Illustrated catalogue of dynamos and motors, coal-cutting machines and alternating current motors, with prices and full information. *(b)* Several sheets with illustrations of recently constructed machinery.

Bryan Donkin & Co., Limited, Bermondsey, London.—Illustrated catalogues of *(a)* valves and other fittings for gas works; *(b)* "The Perret" patent furnace for burning refuse fuels; *(c)* exhausting plant, fans, etc.; *(d)* miscellaneous sheets, pricing fans, steam valves, oil and gas engines.

Joseph Baker & Sons, 58 City Road, London.—*(a)* Illustrated catalogue and price list of fruit cleaning and drying machinery, coffee-roasting machines, tea cutting and mixing plant. *(b)* Circular illustrating and pricing patent disc coffee mills.

G. Diechmann & Sohn, Berlin, Germany.—Illustrated catalogue of English and American machine tools suitable for the German market. The machines are divided up according to the names of the manufacturers.

Fraser & Chalmers, 43 Threadneedle St., London.—Pamphlet describing the "Sederholm" boiler, specially suitable for high pressures and large units. Fully illustrated.

T. Richardson & Sons, Limited, Hartlepool, England.—Illustrated pamphlet describing Morison's evaporator and feed water heater for marine boilers, also giving particulars of Geddes patent pulsator water drainers.

Merryweather & Sons, Limited, 63 Long Acre, London.—Cloth bound catalogue, entitled "Water Supply," giving a description of the engineering procedure and plant necessary for water supply and power plant for villages and country houses.

R. W. Blackwell & Co., 39 Victoria St., Westminster.—Illustrated catalogue and price list of the "Chicago" crown and plastic rail bonds, with full description of method of laying, tools required and costs.

James Clegg, 10 Milnrow Road, Rochdale, England.—Catalogue of second-hand books for the engineering profession.

H. J. H. King & Co., Nailsworth, Glos., England.—Illustrated catalogue of speed governors for turbines and water wheels, friction clutches and steam engines. Full dimensions and prices.

Brouhot & Cie., Vierzon, Cher., France.—*(a)* Illustrated catalogue of steam engines, pumps and agricultural machinery; *(b)* price list of same; *(c)* catalogue of gas and oil engines, with testimonials. Illustrated.

Snowdon, Sons & Co., Limited, Millwall, London, E.—Large illustrated price list of a variety of lubricants and lubricators, prominent among which are the "Snowdrift" lubricant and the Berry-Snowdon automatic lubricators. Packings, non-conducting compositions, boiler fluids, etc., are also priced.

The Britannia Company, Colchester, England.—Cloth bound book, entitled "Screws and Screw-making," the first half of which is a treatise on screw-making in all its branches, while the second half illustrates and describes a full line of machine tools, engineers' hand tools, etc. Prices are given.

The Kingfisher Patent Manufacturing Company, Leeds, England.—Circulars describing *(a)* the Emissary electrical lubricant; *(b)* sight feed lubricators; *(c)* various lubricating specialties.

The Bristol Wagon and Carriage Works Company, Limited, Laurence Hill, Bristol, England.—Illustrated catalogue of carts, wagons, vans, etc., of all descriptions, for private, business and farming purposes. Prices are invariably attached.

William Johnson & Sons, Armley, Leeds, England.—Catalogues of brick and tile making machinery, elevating and conveying plant, grinders, separators, etc. Illustrated.

The Croft Foundry Company, Walsall, England.—Circular giving illustrations of special castings for the cycle and gun trades.

H. Munzing, 199 Upper Thames St., London.—Price list of radiators and apparatus for warming by steam or water; also of the Mercer sectional safety boiler.

Screw Boss Pulley Company, Limited, Thrapston, England.—*(a)* Price list of pulleys, shafting and mill accessories, among which is the Smith self-oiling plummer block; *(b)* pamphlet containing illustrated description of the firm's works.

William Summerscales & Sons, Limited, Coney Lane Works, Keighley, England.—*(a)* Laundry and cooking machinery catalogue, illustrating a full equipment for steam laundries, steam carpet beaters, bakers' ovens, stoves, etc.; *(b)* illustrated price list of wringing and mangling machines, sewing machines and miscellaneous agricultural plant; *(c)* folder price list of garden rollers.

Samuel Denison & Son, Hunslet Foundry, Leeds, England.—Illustrated price list of weighing machines, railway and road weigh-bridges; also of suspended weighers, wire testing machines, etc. Full data and dimensions are included.

The Kilbourn Patent Refrigerator Company, Limited, 23 Dublin St., Liverpool, England.—*(a)* Illustrated catalogue of refrigerating installations for cold storage, with lists of plant supplied; *(b)* catalogue of dairy refrigerating plants and other dairy appliances.

The Coil-Clutch and Pulley Company, Limited, Slough, Bucks, England.—*(a)* Series of illustrated circulars describing Lindsay's coil clutch and its applications to rolling mills, cranes, etc.; *(b)* copies of several testimonials from users.